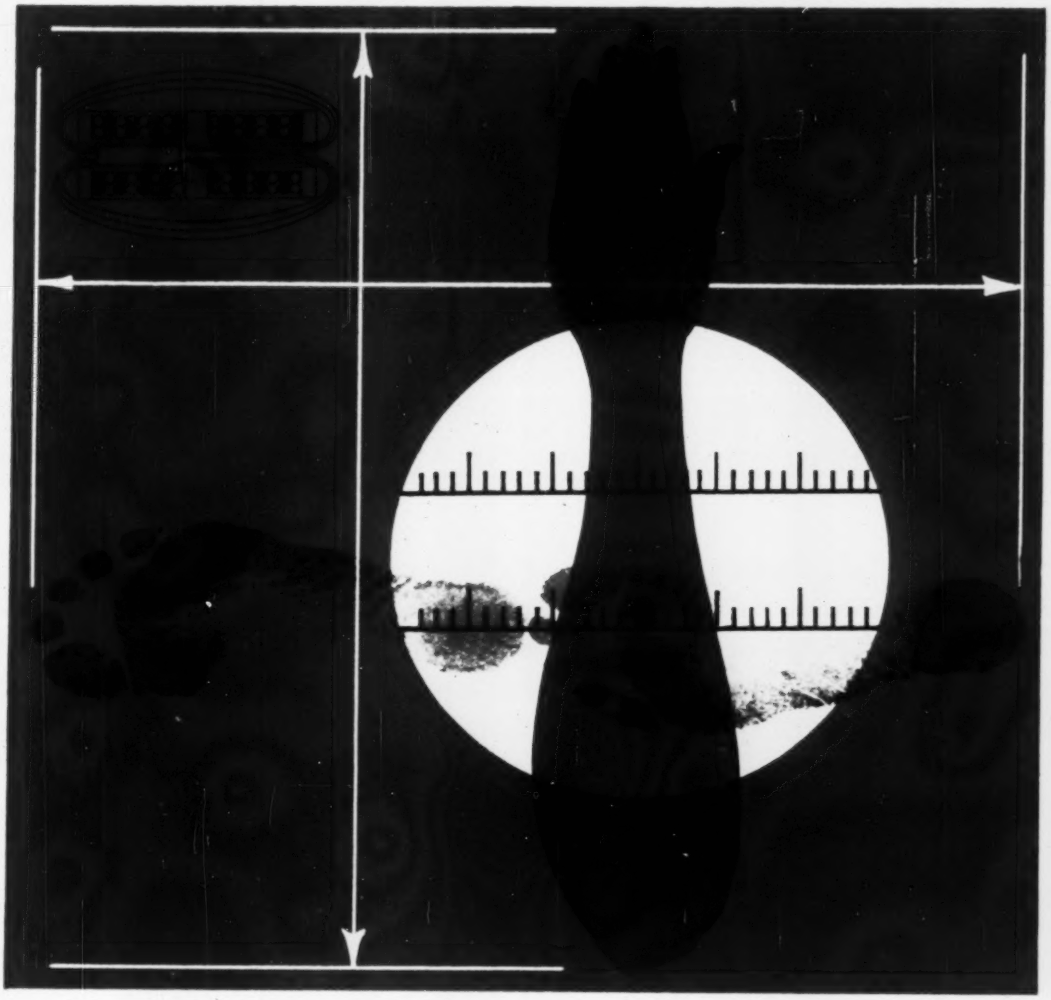
INSTRUMENTS AND CONTROL SYSTEMS

INCLUDING: INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER



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OCTOBER 1960

Dividing Pulse Trains 1716
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One Ten-Millionth of an Inch 1733
Electronic Control Systems 1742
Manual Timing Techniques 1747

GPE Controls Model R790 **Electric Integrator** gives you direct integrated 6-digit read-out of any flow that can be represented by a D.C. electrical signal—with accuracy to within ½ of 1% over flow turndowns of as much as 10 to 1. Chart planimetering is eliminated. Unaffected by temperature changes from −30° to +130°F. Designed for use with GPE Controls linear signal electric flow transmitters, but suitable for many other applications as well.

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X 1000

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LEWIS PORTABLE PYROMETER POTENTIOMETERS

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- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY

ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

- Three models from which to choose the instrument for your application.
  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

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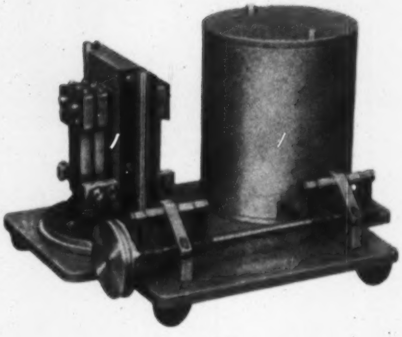
NAUGATUCK, CONNECTICUT
Manufacturers of Complete Temperature Measuring Systems for Aircraft

CIRCLE 2 ON READER-SERVICE CARD

NEW! SENSITIVE RESEARCH "COMMANDER" INSTRUMENTS

LOW THERMAL CHOPPERS

The Types 9742, 9743, and 9744 Low Thermal Choppers have resulted from design work accomplished at the National Research Council in Ottawa, Canada. Their construction makes them particularly adaptable to circuits where thermal noise is of importance, such as in low level DC amplifier applications and Hall Effect measurements.



Type 9744
with one cylinder removed

SPECIFICATIONS

THERMAL EMFs: *0.02 μv or less.*

CONSTRUCTION: Contain 2 (Type 9742), 3 (Type 9743), or 4 (Type 9744) DPDT switches, all actuated by a common shaft. Switch arms are made of copper. Contacts are solid gold blocks. Switch sections are separated by electrostatic screens and surrounded by heavy metal covers to maintain thermal equilibrium. The Type 9743 is particularly adaptable for OEM applications because of its small size (3½" x 5¼" x 4" high).

RELATIVE PHASE OF SWITCHES: Adjustable through 360° by rotating the cams on the shaft.

MAKE/BREAK RATIO: Each contact can be separately adjusted from 0 to 100% of a cycle with an accuracy of ±1%.

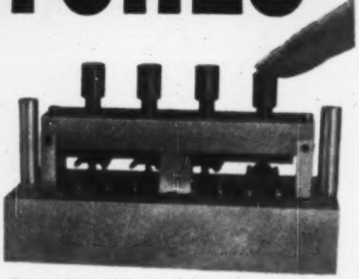
CURRENT CAPACITY: Depends whether circuit is resistive, capacitative or inductive. Will usually operate in purely resistive circuits to interrupt up to 100 millivolt amperes. Correspondence necessary for special applications.

CHOPPING FREQUENCIES: Speeds up to 60 cps. are normal. Optimum speed depends on applications, i.e. in a DC amplifier operating from a 60 cycle supply, a maximum rejection of 60 cycle pick-up can be obtained at a speed of approximately 37.5 cps. Speeds up to 90 cps. can be used by increasing the tension of the spring on the rod return.

DRIVING MECHANISM: A small synchronous motor capable of a 0.8 inch-oz. torque (Not furnished)

LOW THERMAL SWITCHES

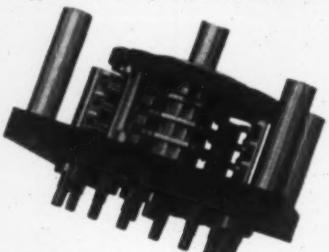
The Type 9145 Low Thermal Selector Switch is intended for use in potentiometer or other circuits where the generation of stray emfs must be kept to an absolute minimum. Its construction (based upon an ingenious design by Dr. T. M. Dauphinee of the National Research Council in Canada) assures a positive circuit connection by the use of self-wiping contacts while the generation of thermal emfs under all possible conditions is limited to less than 0.01 μv. The switch contains 4 DPST sections with all tellurium-copper contacts and is mounted in a solid block of aluminum to minimize temperature gradients. Operation is made simple by allowing for the selection of any one of 4 circuits by merely depressing a push button. The buttons lock down automatically and release when any other button is depressed. Two or more buttons may be simultaneously depressed if desired. A separate release button is provided to open all circuits. The terminals can be cross connected for applications requiring a reversing switch.



Type 9145 with panel & case removed

Dual Contact Switches. A wide variety of standard and special self-cleaning dual contact switches are available for transfer and/or reversing applications demanding the highest degree of precision and reliability.

The complete wiper or brush is made up of two assemblies, each with 8 individually sprung contact arms that are separated and riveted together at the center. The elasticity of the wiper arms maintains the whole assembly against the inner surfaces of the center segments of the brush and the stationary contacts. This arrangement effectively allows the wiper to "float" between the stationary contacts since it is not mechanically held in place other than by the pressure of its own individually sprung arms. Hence, contact pressure and contact resistance is always constant. All copper contacts are used when low resistance or thermoelectric free switches are required. The generation of thermal emfs can be kept as low as .01 μv. For exceptionally low resistance applications, the wiper assemblies can be paralleled. Switches with copper contacts have a resistance as low as 100 microhms between soldering points and will vary less than 10 microhms between contact points.



Dual Contact Switch

The Type 9600 Low Thermal Reversing Switch with oil immersed all copper contacts simplifies and speeds up the operation of precision potentiometers. By a single turn of the switch the potentiometer battery and two measuring circuits are reversed and the galvanometer is disconnected during the change over. If only one measuring circuit is in use the spare section of the switch can be utilized to reverse the standard cell and thus make it possible to check the standardization of the potentiometer with either a + or − connection of the battery. In the battery circuit the switch contacts do not introduce a change in resistance large enough to significantly affect the potentiometer current. The maximum change of contact resistance on reversal does not exceed 100 $\mu\Omega$. In a typical potentiometer of 100 Ω resistance this would cause a change in current of 1 ppm.

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INSTRUMENTS AND CONTROL SYSTEMS

VOLUME 33, NUMBER 10, OCTOBER 1960

STANDARDS for measurement have always been important in rational society. Today's standards and gaging procedures are more sophisticated than yesterday's foot and cubit methods. Reports begin on page 1719.

EDITORIAL

15th Annual ISA Conference & Exhibit 1711

FEATURE ARTICLES

Frequency Counter 1715

ROSS E. HUPP—a counting technique which uses a sensing device that counts N events of the frequency to be measured and opens gate for this interval

Dividing Pulse Trains 1716

WILLIAM P. HORTON—eight circuits that divide a series of pulses

Pneumatic Gaging 1719

DAVID B. KIRK—a rapid inspection technique in which workpiece dimensions are compared to dimensions of highly accurate ring and plug master gages

Displacement Transducer 1723

HARRY F. MOORE—this device converts minute changes of capacitance resulting from the displacement of a sensor into output voltages

The Linear Variable Differential Transformer 1724

WALT W. WINTERS—the LVDT is a basic displacement-measuring device, featuring simplicity, accuracy and electrical signal output

The LVDT In Motion Measurement 1730

A. J. HORNFECK—the adjustable-core transformer is used extensively in measuring position or motion

One Ten-Millionth Of An Inch 1733

ALBERT M. DEXTER, JR.—fourteen manufacturers helped co-sponsor a project at NBS to develop and measure standards to 0.1 millionth of inch

Kearfott's Metrology Department 1735

J. FLYNN—facilities, procedures, equipment capabilities of experienced mechanical metrology department

NBS Gage Block Calibration 1738

What To Look For In Electronic Control Systems 1739

WALTER S. SHARSHON—initial cost of instrument units does not indicate total system installation cost, nor long-term operational costs

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INSTRUMENTS AND CONTROL SYSTEMS

VOL. 33 NO. 10

OCTOBER, 1960

PRINT ORDER THIS MONTH: 39,500

A Critical Review Of Electronic Control Systems 1742

WARD F. O'CONNOR—a frank analysis of the problems and limitations of some of the systems in use, and suggestions on how to approach a control problem

The Strain-Gage Transducer 1745

EDGAR S. GILCHRIST—one advantage over other transducers is its insignificant mass which makes it resistant to acceleration and vibration error

Manual Timing Techniques 1747

GASTON G. WILEY and JACK W. HEUER—basic techniques, including cumulative, instantaneous sequential, and split-action timing; hours indications, and recording techniques

Process Control Systems 1751

FRED D. MARTON—flow of cooling water regulated by adjustment of variable-speed drive on pump; bubbler keeps docks and bilges dry

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ADDITIONS to our previous staff report on weighing techniques and devices

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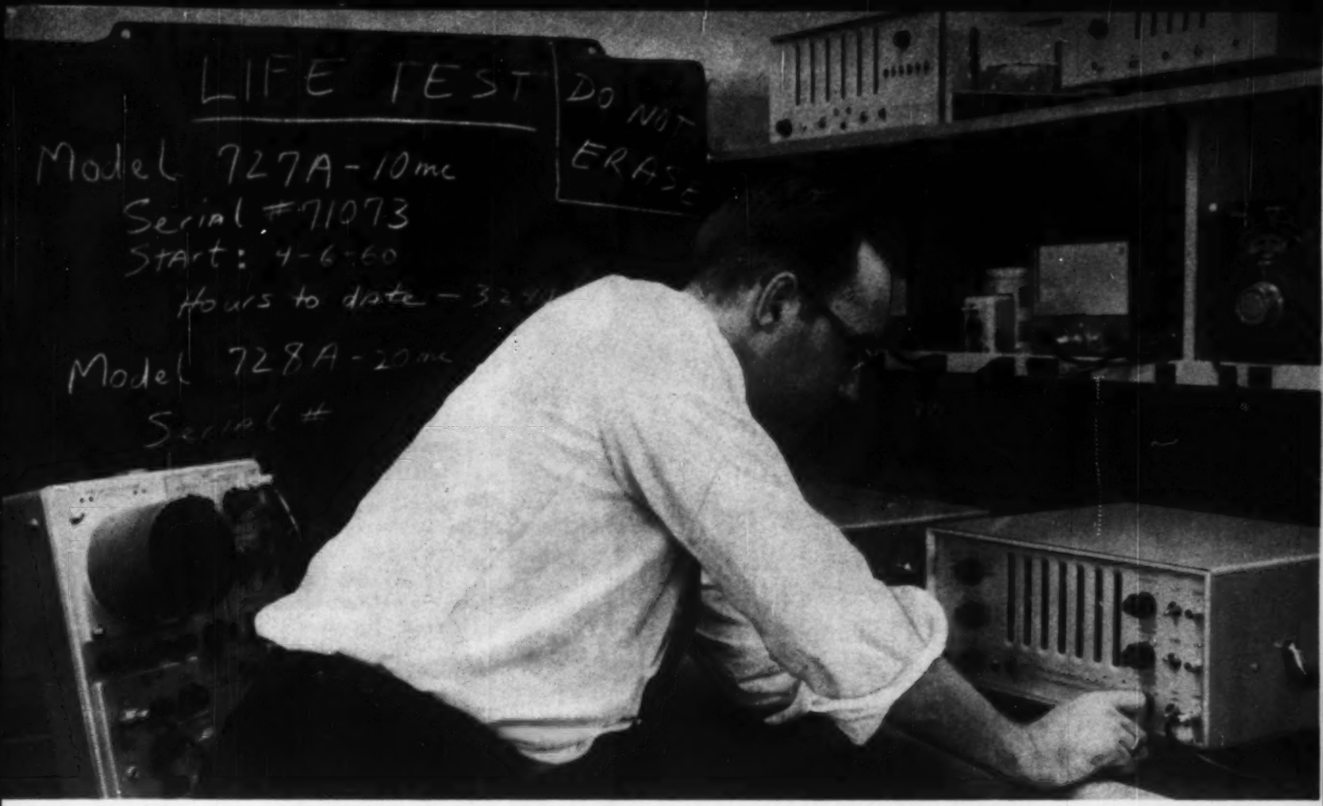

How long will you keep buying obsolete counters when CMC counters with solid state reliability cost so little more?

Announcing the CMC 728A

A SOLID STATE 20 MC UNIVERSAL COUNTER-TIMER

Introduction of the CMC 728A marks another frequency step-up from the company that brought you the first transistorized universal counter-timers. CMC, the leader in truly advanced counting, timing, and frequency measuring equipment offers 100 kc, 250 kc, 1 mc, 10 mc and now 20 mc all solid state instrumentation.

Can You Afford To Settle For Less? If you are considering any counter, will your engineering judgement and sense of *real* economy dictate purchase of old fashioned equipment? Stop and look at the merits of solid state counters. Did you know that the reliability of all CMC solid state counters is backed with a 2 year warranty—double the guarantee of tube counters? Did you know CMC's solid state 10 mc universal counter timer only costs $200 more than comparable vacuum tube counters? That's the beginning. Compare the rest of these specifications.

	Most Popular 10 mc Vacuum Tube Counter	CMC Solid State 10 mc Counter
Base Price	$2,300	$2,750
Printer Output	75	n/c
Time Interval Section	175	n/c
Total	$2,550	$2,750
Weight	118 lbs.	27 lbs.
Size	21⅛"H x 20"W x 23½"D	7"H x 17"W x 13"D
Power Requirements	600 watts	46 watts
Accuracy	± 1 count ± crystal stability	± 1 count ± crystal stability
Remote Programming	not available	Standard option
Warranty	1 year	2 years
Time Interval Measurements	1 μsec to 10^7 sec in 1 μsec increments	0.1 μsec to 10^7 sec in 0.1 μsec increments
Period Measurement	0 cps to 10 kc	0 cps to 3 mc
Gate Times	0.001, 0.01, 0.1, 1.0 & 10 sec	0.000001 to 10 sec in decade steps
Time Base	10 to 1 multivibrator type	decade dividers — no adjustment

Compare the 20 mc Solid State Universal Counter-Timer—We'd like to, but frankly, there aren't any comparable vacuum tube counters. This might lead the discerning engineer to think that at 10 mc, vacuum tubes are driven "hard", right to their capacity. *And he'd be right.*

More Information—For complete technical information on high reliability solid state counting instrumentation, call your nearby CMC engineering representative, offices in 33 cities throughout the U.S. and Canada, or write directly to Dept. 5510.

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A Division of Pacific Industries
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Phone: EMpire 7-2161

CIRCLE 4 ON READER-SERVICE CARD

from

Instrument Calibration

HEADQUARTERS

The proven method of maintaining Accuracy

Improved reliability and sustained quality control, through periodic calibration of test instruments, can be achieved by semi-skilled personnel using either of these self-contained standards.

Model 829 provides full-scale calibration accuracy of 0.5% for both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. AC calibrations can be performed from 50 to 400 cps., depending on line frequency used, or unit can be driven by optioned variable frequency power supply. Automatic protection for both operator and instrument under test is provided by interlocks and high voltage discharge circuits. Net price $2,650.

Model 829A provides full-scale calibration accuracy of 0.25% for AC and DC meters over same ranges as Model 829. Horizontally mounted standard meters are employed, and a fluorescent light is provided for proper illumination. The illustration shows the Model 829A mounted on the Model 10 Test Equipment Cart with the standard meters recessed into a drop-leaf work shelf. Mounted inside the Cart is the Model 500 Variable Frequency Power Supply which will supply any frequency for calibration from 50 to 400 cps., plus excellent line regulation. Net price of Model 829A with special Weston meters is $3,150.

Performance is rigidly guaranteed. Prices are f.o.b. Boonton, N.J. and subject to change without notice.

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

CIRCLE 5 ON READER-SERVICE CARD

LETTERS TO THE EDITOR

Editor, I&CS:

In case there are other confused "binary beginners," you might point out that Mr. Robert Brooks (Gray-to-Binary Conversion) is talking about number 36, *not* 38, on page 1312 of your August issue.

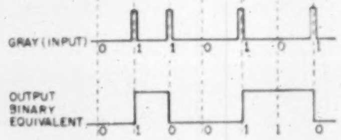
Edwin L. Smith
Electronics Engineering
Bell & Howell Company
Chicago, Ill.

Editor, I&CS:

I have been following your articles on Digital Instrumentation with great interest. However I was puzzled by the article by Robert Brooks in the August issue (pages 1311, 1312). To my knowledge binary 38 is 0100110. How will the conversion work in this case?

Bert Wolf
Rego Park 74, N. Y.

The article showed how the conversion works for 36, but mistakenly called it 38. Here is how it would work for 38:



There is a rule for converting binary to Gray—add the binary to itself without carry, but first shift one number one place to the right, as follows for numbers 36, 37, and 38:

Binary 36	100100
Shift to right	10010
Gray 36	110110
Binary 37	100101
Shift	10010
Gray 37	110111
Binary 38	100110
Shift	10011
Gray 38	110101

Editor, I&CS:

May we all take the opportunity of congratulating you on having done an excellent job (on the *Handbook of Electrical Measurements*).

F. Patrick Johnston
Sensitive Research Instrument Corp.
New Rochelle, New York

Editor, I&CS:

I am an inventor of measurement and control instruments, and have either patents or novel ideas regarding measurements of blood pressure, denier of textile fibers, interface level, and concentration of H_2S in water. I will be glad to assist those persons who indicated that they couldn't measure these variable satisfactory—[What Variables Can't You Measure Satisfactorily??—August, 1960, *INSTRUMENTS AND CONTROL SYSTEMS*].

I have read *INSTRUMENTS AND CONTROL SYSTEMS* with interest for many years and have found it very helpful.

Edwin Bailey, Pres.
Creative Science
Ridgewood, N. J.

Editor, I&CS:

Your *INSTRUMENTS AND CONTROL SYSTEMS*, August issue, pages 1281 and 1282 refers to several needs for more accurate humidity measurements.

Can you put us in touch with the persons who can give us these specifications?

We are especially interested in problems requiring precise relative humidity control or measurement—for instance, relative humidity measurement in missile compartments.

Charles Rosso
Rosso Instruments
Cimarron, New Mexico

This letter will inform the man (and others) with the problem.

Editor, I&CS:

In the August issue of your magazine, we note with interest the article "What Variables Can't You Measure Satisfactorily?" The type of instrumentation we are presently manufacturing may be of value in a number of the problem areas cited.

Boonton Polytechnic Company, Inc. manufactures moisture-determination equipment operating on the principle of radio-frequency power absorption. We have been successful in the measurement of moisture to an accuracy of 0.001% in some products, and the instruments has been shown to be sensitive to the presence of moisture to one part per hundred thousand. Moisture analyzers have performed satisfactorily on a number of products including foods, pharmaceuticals, nylon, cellophane, etc.

Our instrumentation can be applied

hays

RAMBLINGS ON INSTRUMENTATION

Reflections on a Second Soviet Sojourn

Editors note: Attendance at the recent International Federation of Automatic Control Congress in Moscow provided Mr. Sprague with an opportunity to continue his practice of picking the brains of intelligent U. S. Engineers overseas— just as he did some two years ago on another Russian junket . . . Herewith, his latest flights of fancy.

Department of Unsupported Generalizations

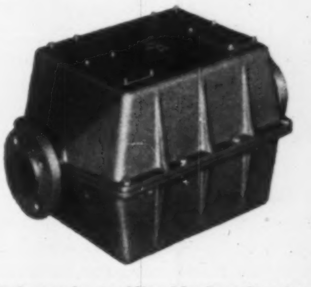
1. Russian automatic control engineers are more theoretically oriented than their U. S. Counterparts. However, they are concerned with the *same* theoretical problems that we are and—to the degree one could determine in a short visit—are not ahead or behind us.
2. The United States still is considerably ahead in the *application* of instruments and controls (we've got more of a greater variety of devices in daily use) but Soviet engineers have become more application-minded in the last two years.
3. A decision has been made at the highest level of the Russian government to go "all out" on automation. One gets the impression that whatever the Soviet control experts want in money, facilities, and people will be forthcoming and that, when this "wherewithal" is added to the talent and dedication possessed by their engineers and scientists, we can expect substantial progress on their part.
4. More automatic control "decentralization" is being practiced by the Soviets than two years ago. In 1958 one got the impression that "thinking will be done in Moscow; the best ideas worked out in Moscow will be practiced in the hinterlands". In 1960 one got the impression that "it's o.k. for people to think, to get automatic control ideas and to apply them whether they are in Moscow or not or whether they agree with Moscow or not".

Department of Unanswered Questions

How does a free society match the concerted effort of a centralized society in a particular field (specifically automatic control)? If it decides it must match or exceed that effort, how does it "keep score", i.e. know whether it's ahead or behind? How, for that matter, does it profile on a continuing basis the quality and quantity of its own effort? Through technical conferences, exhibits, magazines, etc? If so, shouldn't the role of technical societies be enlarged in the future to include a "report to the people" of the U. S. on our position in an important technical field? And, if we concluded that we were behind the Russians in automatic control, what should we do about it? Seek federal aid for universities working in automatic control? Give special tax write-offs for R & D work done by instrument companies? Set up a "Cabinet Minister For Automation"? And wouldn't this be simply adopting Russian methods to solve the problem? Help! Help!

Rifle Shot

We believe that we have developed the most accurate, most stable ONE INCH Electromagnetic Flowmeter in the market. We do not have two inch, four inch, six inch, eight inch, or eighty-four inch meters at the moment—though we hope to have them in the near future—so please *do not* write us for information on these sizes. But, *if* you are interested in a ONE INCH obstructionless electromagnetic flowmeter with these features:



- Independent of liquid viscosity, temperature turbulence, and density.
- Continuous range adjustment possible between 10 and 100% of transmitter calibrated flow—three position selector (10, 50, 100%) also available.
- ½% system accuracy.
- Conductivities handled to as low as 0.05 micromhos per cm³.
- Common mode noise rejection—better than 3000:1.
- Adjustable system damping.

We would like to hear from you. Who knows—we might be able to help each other.

Phil A. Sprague
President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

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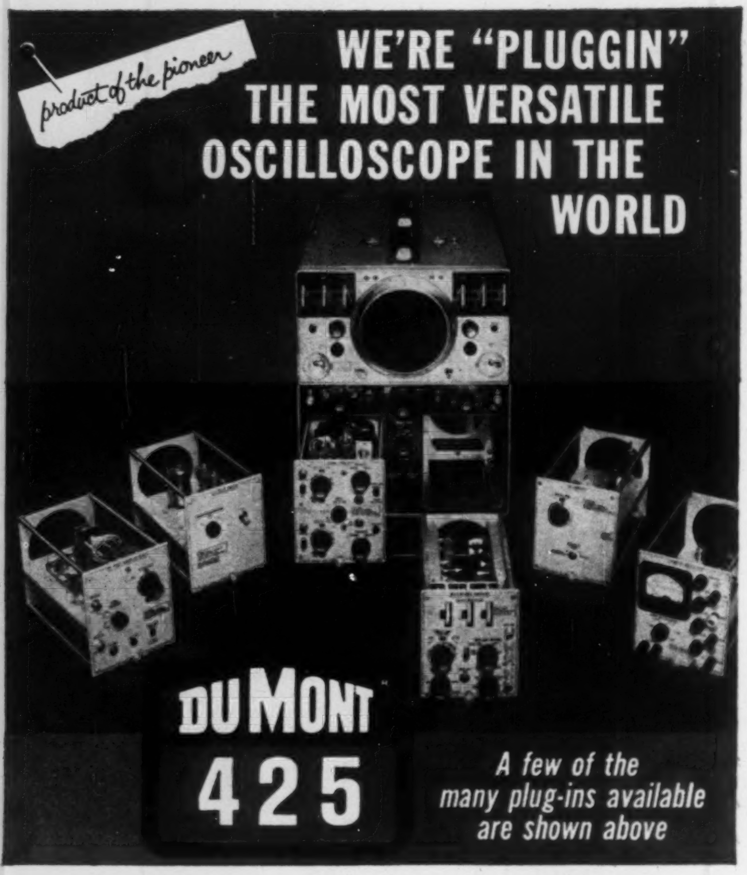
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WE'RE "PLUGGIN" THE MOST VERSATILE OSCILLOSCOPE IN THE WORLD
DU MONT
425
A few of the many plug-ins available are shown above

The first oscilloscope with digital *and* printed ReadOut, now provides—through an ever increasing selection of functional plug-ins—the greatest versatility available in any commercial high-frequency oscilloscope. It defies obsolescence. Two plug-ins used simultaneously—unique with the 425—provide the most complete, technically-sound combinations of circuit functions obtainable for universal testing.

- DC to 35 mc—useful to 60 mc
- Accurately repeatable measurements —even by untrained personnel
- Direct-reading digital ReadOut of measurements
- Two plug-ins used simultaneously
- Analog to digital converter—external recorders of all types
- Electronic switches on X, Y and Z axis

PLUG-INS PRESENTLY AVAILABLE

Type	Description
4201 Y-Preamplifier:	dc-35 mc, sensitivity 50 mv/cm to 20 v/cm
4202 Dual Trace:	dc-33 mc on both traces; 11 nsec rise time
4203 Delaying Sweep:	25 nsec to 10 sec delay, continuously variable
4204 X Input:	deflection factor 2—10 v/cm; dc to 4 mc
4205 Y-Preamplifier:	dc-21 mc; sensitivity 5 mv/cm to 2 v/cm
4207 Y-Test:	provides signals for adjusting 425/425-R
4208 Power Access:	Supplies multiple potentials for breadboarding or testing
4209 Micro Delay:	0—100 nsec delay; resolution better than 0.1 nsec
4211 Sweep Expander & X-Preamplifier:	permits time shared X vs Y and Y vs Sweep displays; dc to 1.5 mc
4213 Raster Display:	Provides a crystal controlled raster for precision time measurement

PRICE **$2750.00**
(without plug-in)

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DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
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CIRCLE 7 ON READER-SERVICE CARD

to most of the sub-categories listed under Humidity, Density, Level. In addition to those which are specifically related to moisture, we may be able to make a significant contribution to such problems as: Consistency, Gas Density, H_2S in Water, Percentage of Petroleum Solvent in Mixture, Saturation Point of Carbon Bed, Air/Fuel Ratio, End Point of Light Hydrocarbons.

Louis T. O'Neill
Boonton Polytechnic Co., Inc.
Boonton, New Jersey

Editor, I&CS:

The summary titled "What Variables Can't You Measure Satisfactorily?" on page 1280 of Volume 33 is a particularly fine compilation of trouble areas in the measurement of process variables. We note several areas, such as percent solids or percent of solvent mixtures, in which we have recently developed specialized non-destructive capacitive-type instrumentation capable of resolving dielectric compositions to better than ½ percent.

Other parts of the list have stimulated our interest to attempt further development of the capacitive techniques in an attempt to develop new instrumentation capable of meeting the outlined requirements.

Carrol C. Sachs, Pres.
Admerco, Inc.
9938 *Clybourn Ave.*
Sunland, Calif.

The letters above will inform the men with the problems.

Editor, I&CS:

It will be greatly appreciated if you will forward tear sheets for the series of articles on Symbolic Logic which have been appearing recently in "Instruments and Control Systems."

R. B. Palme
Western Electric Co.
Princeton, N. J.

The "symbolic logic" material, has been running as part of our Digital Techniques series in I&CS, in every issue since February, 1960.

CIRCLE 8 ON READER-SERVICE CARD⟶

How to get accurate data on a small recorder

Ampex's new CP-100 nicely balances four desirable qualities

Compact. Definitely, and a great advantage in trailers, in airplanes, in submarines, or even in regular laboratory use. There's complete front access to everything. All-transistor amplifiers and power supplies cut power needs and keep down the heat – an advantage in tight equipment layouts.

Portable. We'll frankly admit it takes two men to carry it – not just one and a half. But by calling in an occasional fractional man (or by using an accessory dolly) you gain exactly the needed performance that portables have lacked until now. In laboratory use, the CP-100 is "bench-top equipment."

Precise. Let the numbers talk. Though compact, the CP-100 is a full-fledged, uncompromised laboratory recorder: 200 kc response at 60 ips tape speed (and proportional at others); flutter well within telemetered-data requirements; intermodulation distortion so low it never adds spurious data of its own.

Universal. Yes, in numerous ways. The CP-100 isn't fussy about power; takes 115 or 230-volt AC at 50, 60 or 400 cycles or 28-volt DC from batteries or generator. Kinds of data: direct or FM-carrier, by interchangeable plug-in amplifiers. And it records and plays back as well.

The essential data

Model: CP-100 Compact Recorder/Reproducer. *Reel size and tape width:* 10½-inch reels with ½- or 1-inch tape (as specified). *Types of recording:* direct or FM carrier by plug-in interchangeable amplifiers. *Tape speeds:* 60, 30, 15, 7½, 3¾ and 1⅞ ips. *Frequency response:* direct, 300 to 200,000 cps ± 3 db at 60 ips; FM carrier, 0 to 20,000 cps at 60 ips; response at other speeds proportionate. *Tape compatibility:* yes, with Ampex FR-600, AR-200 or interchangeable with FR-100, FR-1100, 300 and 800 series.

May we tell you more? Please write

AMPEX

AMPEX DATA PRODUCTS COMPANY

Box 5000 • Redwood City, California • EMerson 9-7111

CIRCLE 8 ON READER-SERVICE CARD

Never before such precise temperature control at this price!

$120 (SENSOR EXTRA)

Honeywell's new Resistance Bulb Controller responds to temperature changes as small as 0.1°, yet is modestly priced.

Honeywell's new R7087 temperature controller is a precision instrument designed for industrial use wherever temperatures must be precisely controlled: in packaging and plastics processing; plating tanks; annealing, bakery and paint-drying ovens; and in laboratory applications. Unusual flexibility is gained through a wide choice of sensors making ranges from −150° to +1400° F. possible. Centigrade scales are also available.

The new transistorized controller compensates for ambient temperature variations. Sensor connections of regular 18-gauge copper wire may be used up to 300 feet without sacrificing accuracy. Time proportioning with adjustable cycler timing is provided.

Panel lights indicate when unit is below, on or above set point. Controller can be surface-or flush-mounted, features illuminated dial. Other models are available with position proportioning.

For further information, call your local Honeywell office. Or write, Honeywell, Minneapolis 8, Minnesota. In Canada contact Honeywell Controls Limited, Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

75th YEAR PIONEERING THE FUTURE

CIRCLE 9 ON READER-SERVICE CARD

LETTERS TO THE EDITOR

Editor, I&CS:

We would greatly appreciate your sending us 1 reprint of your article Report of High School Course in Modern Engineering Physics, published in *INSTRUMENTS AND CONTROL SYSTEMS*, Feb., 1959 for our files.

G. Y. Kenyon, PH. D.
University of Wichita
Wichita 8, Kansas

Editor, I&CS:

While visiting the Moeller Instrument Company in Richmond Hill I glanced through your publication *INSTRUMENTS AND CONTROL SYSTEMS*, which interested me very much.

The Board of Education, through funds provided by the State Education Department and the National Defense Act has provided $70,000 for the equipping of a laboratory in Instrumentation and Control Systems in the New York City School system, as a pilot course for such a curriculum to be taught throughout New York State. I have been assigned the job of collating this course. Together with several other members of a State Wide Committee we now have a course of study which we feel is workable.

Also, I am setting up the laboratory with the funds allotted and with the help of many instrument manufacturers. The course itself is limited to the areas of flow, temperature, pressure and time.

In such a program it becomes necessary for us to have a good teacher. As this course is to open in October 1961 I am on the lookout for a prospective teacher who could teach physics and instrumentation.

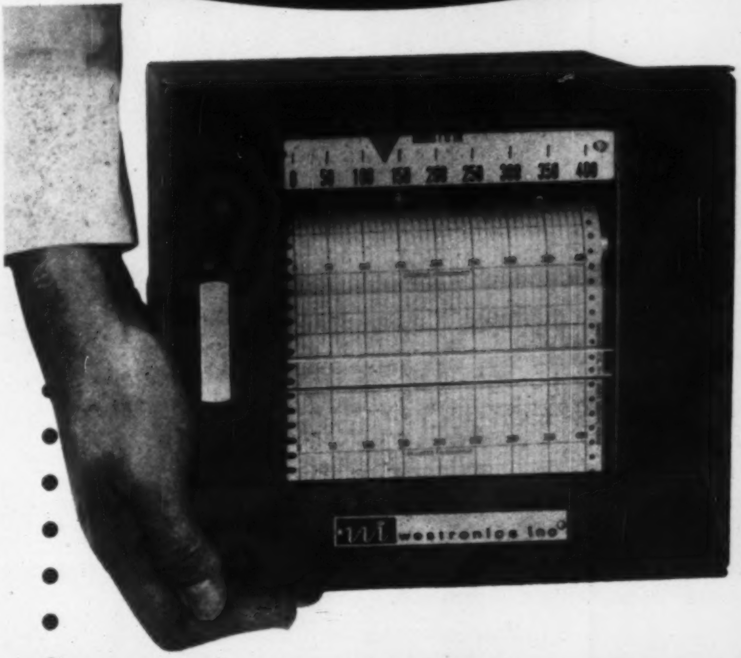
I am particularly interested also in the method of selecting students because I feel that the teaching of instruction on a secondary school level entails a high type of student with ability to absorb the scientific and physical knowledge but also have the ability to absorb the mathematics necessary which goes along with this course.

Adolph Suchy, Chairman
Electronics & Science Department
Queens Vocational High School
Long Island City, New York

Another FIRST!

from

westronics

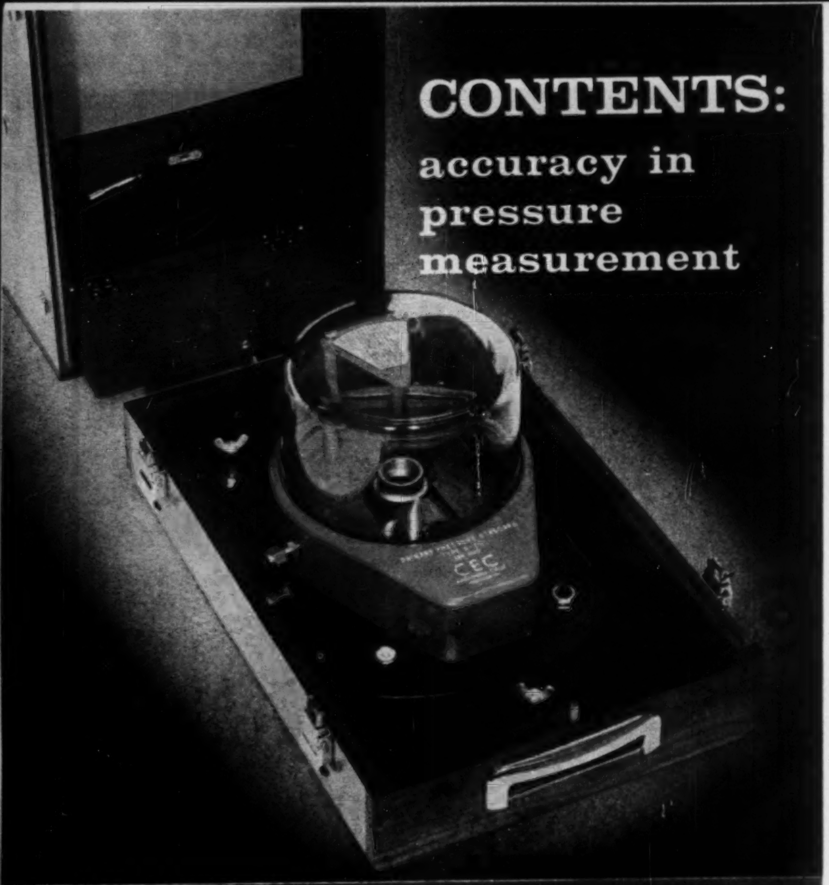


MINIATURE
MULTIPOINT
RECORDER

12 POINTS ON 5 INCH CHART

wi westronics, INC.
3605 McCART STREET ★ FORT WORTH, TEXAS

CIRCLE 10 ON READER-SERVICE CARD



CONTENTS: accuracy in pressure measurement

Here's the starting point for precision calibration of pressure measuring instruments . . . here's where accuracy begins. It's CEC's portable 6-201 Primary Pressure Standard, a pneumatic dead-weight piston gage that assures resolution of 0.005% of reading.

This lightweight instrument is so simple to operate that its accuracy of gage and absolute calibrations is all but independent of operator technique.

The 6-201 covers six pressure ranges between 0.3 and 500 psi, with accuracy of 0.015% of full scale in the 1.5, 5.0, 15 and 50 psi ranges and 0.025% of full scale in pressure ranges of 150 and 500 psi.

Because the 6-201 relies only on fundamental dimensions for measurements, it is independent of any other instrument for its calibration. It uses mass, length and time for its references.

For complete information on the 6-201, write for Bulletin CEC 1581B-X29. For data on CEC's integrated line of instrumentation and pressure measurement devices, ask for Bulletin CEC 1300-X19.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS/pasadena, california

A SUBSIDIARY OF Bell & Howell · FINER PRODUCTS THROUGH IMAGINATION

LETTERS TO THE EDITOR

Editor I&CS:

I am an electronic technican working on flight simulators. About two years ago a letter was published in your column from a man that was interested in forming an association for technicians along the lines of the engineering associations.

If such associations now exist or are being formed I would like to correspond with them as I feel that industry and the technician both would benefit.

James E. Fox
Link Division
Binghamton, N. Y.

Editor, I&CS:

Congratulations on the fine article "The Electrical Standards Lab" (by C. E. White) in the April 1960 issue of *INSTRUMENTS AND CONTROL SYSTEMS.*

Ronald A. Whitburn
Hewlett-Packard Co.
Palo Alto, Calif.

Reader Inquiries

Vibrating Condenser

University professor of physics seeks vibrating condenser of the type used in vibrating-reed electrometers with capacitor of 20 mmf and sinusoidal voltage output. A-647

Centrifugal Filter

Contracting sales engineers seek centrifugal-type filters to remove oil from 125-psig air line. Sizes 1" and 1½" required with plastic bowl and blowdown valve. A-648

NMR and PR Instruments

Veterinarian seeks instruments utilizing nuclear-magnetic-resonance and parametric-resonance principles for application in biological analytical procedures. A-649

Modular Chassis

Consulting engineers in Alaska seek sources of supply for standard modular chassis units for construction of plug-in units, along with trays and rack adaptors. A-650

Gas Specific Gravity

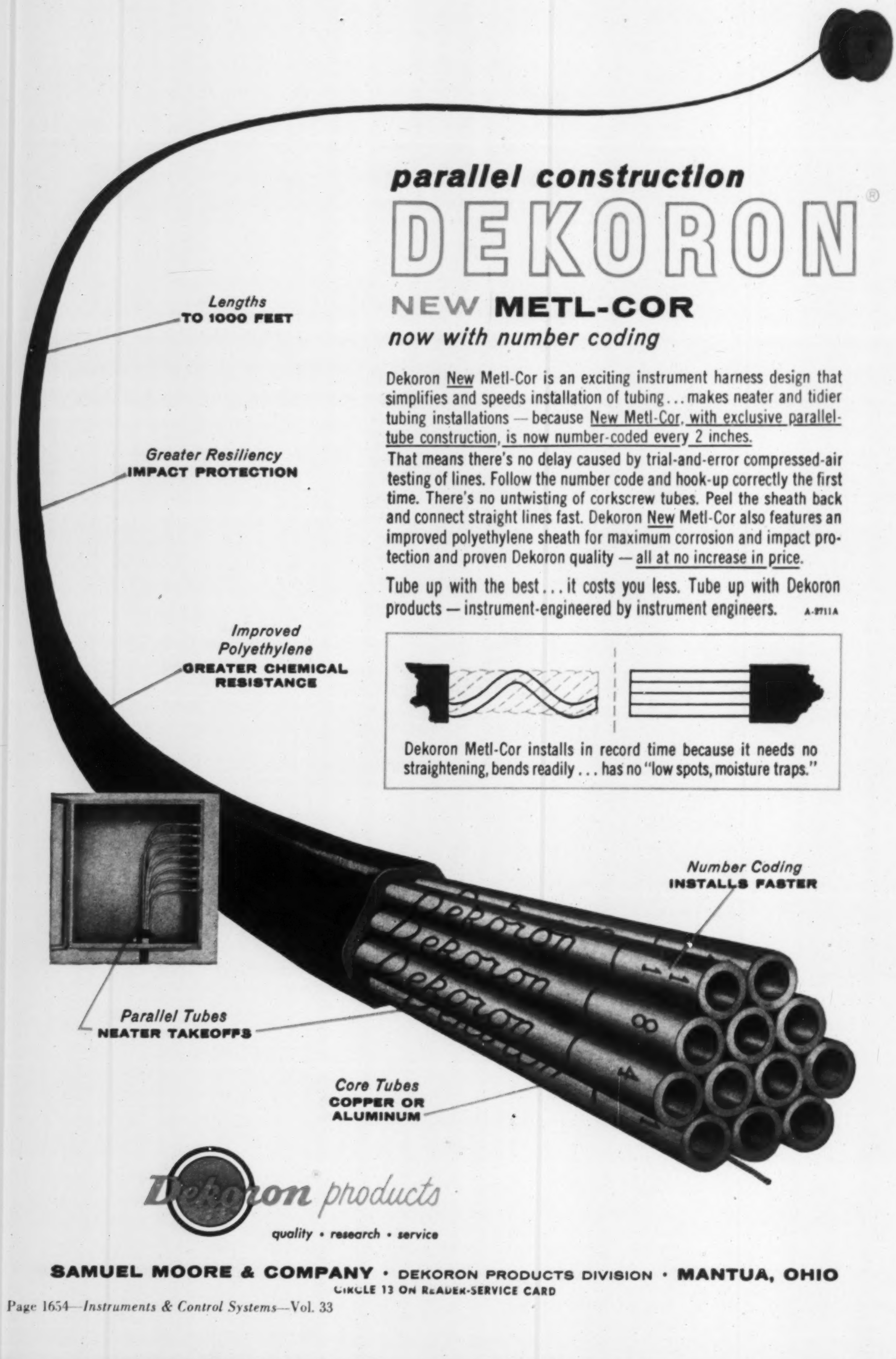
British contracting firm seeks specific-gravity-recording system for petroleum refinery use consisting of local measuring and transmitting unit and remote recorder. A-651

← CIRCLE 11 ON READER-SERVICE CARD

We don't mean to sabotage the competition, but the new Benson-Lehner Electroplotter Model J can only be described as revolutionary. This new digital input graph plotter was designed for highest productivity, allowing you to plot more graphs per hour than ever before. Simple to operate, too. Push-button scaling, dialable origin plus automatic input control over scale, origin and printing. Input is fully buffered which permits reading and plotting simultaneously. A completely automatic print mechanism draws lines, prints numbers and prints symbols. You can get plotting speeds of 400 points per minute with magnetic tape input. The Electroplotter J is a handsome, transistorized single unit instrument with a plotting area of 30" x 30". Point plotting accuracy: 0.05% of full scale. For a confidential report on this new little bomb, don't wait another minute. Strike now! Write **benson-lehner** *Corporation, strategically located at 11930 Olympic Boulevard, Los Angeles 64, California.*

Speaking of revolutionary plotting, Natasha, my dear...

CIRCLE 12 ON READER-SERVICE CARD



parallel construction

DEKORON®

NEW METL-COR

now with number coding

Dekoron New Metl-Cor is an exciting instrument harness design that simplifies and speeds installation of tubing... makes neater and tidier tubing installations — because New Metl-Cor, with exclusive parallel-tube construction, is now number-coded every 2 inches.

That means there's no delay caused by trial-and-error compressed-air testing of lines. Follow the number code and hook-up correctly the first time. There's no untwisting of corkscrew tubes. Peel the sheath back and connect straight lines fast. Dekoron New Metl-Cor also features an improved polyethylene sheath for maximum corrosion and impact protection and proven Dekoron quality — all at no increase in price.

Tube up with the best... it costs you less. Tube up with Dekoron products — instrument-engineered by instrument engineers. A-8711A

Dekoron Metl-Cor installs in record time because it needs no straightening, bends readily... has no "low spots, moisture traps."

Lengths
TO 1000 FEET
Greater Resiliency
IMPACT PROTECTION
Improved Polyethylene
GREATER CHEMICAL RESISTANCE
Parallel Tubes
NEATER TAKEOFFS
Core Tubes
COPPER OR ALUMINUM
Number Coding
INSTALLS FASTER
Dekoron
1
8
4

Dekoron products

quality • research • service

SAMUEL MOORE & COMPANY • DEKORON PRODUCTS DIVISION • **MANTUA, OHIO**

CIRCLE 13 ON READER-SERVICE CARD

Transducer market in 1958 was $100 million, says A. D. Little, Inc. Pressure transducer sales in 1959 were $34 million in 1959; $39 million expected in 1960.

Capacitor sales in 1959 were $234 millions says BDSA, Dept. of Commerce: $267 million says Electronic Industries Association; will increase 59% over 1959 by 1965, says Corning Glass Works. Market in 1960 is about $330 million, says Electronics magazine, compared to $218 million in 1958, $225 million in 1957.

Environmental vibration and calibration testing market for electronic components is now above $25 million annually, says F. Gutterman, President of Industrial Products Division of ITT.

There are 293 scientific and technical groups in the USA, says new 715-page Encyclopedia of American Associations.

Electronic computing market in 1959 was $314 million, says Bureau of Census—$298 million digital and $16 million analog (general purpose).

Ultrasonics market has grown from $15 million in 1956 to estimated $50 million in 1960, should reach $150 million in 1965, says Electronics magazine. Cleaning ultrasonics has 30% of market, measurement and test has 16% ($8 million), remainder goes to welding, alarm, drilling, medical diagnosis, etc.

Anticipating 33% increase in commercial computer shipments in 2 years, GE Computer Dept. (Phoenix) announces plans for 11 new data-processing centers plus 10 additional sales offices.

Machine-tool numerical control market is now $12 million, and will grow to $100 million annually by 1965, says William Moog of Moog Servocontrols, Inc. Major increase will be systems for the smaller manufacturer.

Japan's petroleum demand has risen from 31.5 million barrels in 1937, to 34 million barrels in 1952, to 160 million barrels in 1960, says World Petroleum.

World's refining capacity is 23.43 million barrels/day in 1960, is expected to rise 20% by 1963. Western hemisphere 1960 level is 13.73 million barrels/day, expected to increase to 15.25 million by 1963; Eastern hemisphere capacity is 7.05 million barrels/day, expected to be 9.09 million barrels by 1963, says World Petroleum.

Midwest Council on Airborne Television (MCAT) has received $4.5 million from Ford Foundation and has awarded $2.2 million contract for two TV-equipped DC-6 aircraft which will retransmit educational TV programs over a 6-state area.

Federal research and development in all areas of science currently involve $7.5 billion a year, including more than 100,000 research projects in over 7000 research installations.

WHERE
DO YOU
STAND ON
COMPUTER CONTROL—
LEADING OR LAGGING?

Far-sighted leaders in industry are realizing the benefits made possible by applying computer control systems to their processes.

Working with these leaders, General Electric has already pioneered the application of twenty on-line GE-312 computer systems now being implemented in these basic areas —STEEL, ELECTRIC UTILITIES, CHEMICAL, CEMENT, and PRODUCTION CONTROL for various manufacturing applications.

The GE-312 Computer Control System embodies adaptability and flexibility to meet many types of applications in varying size plants. For example, compare its expansible memory—capacity up to 52,000 words. Compare its flexible input/output—capable of scanning up to 1500 instrument inputs. These are maximum capabilities, expansible from a minimum system. You buy a system tailored to your exact requirements.

Add to this versatile equipment the computer systems engineering ability demonstrated by General Electric in implementing these twenty GE-312 system applications.

Add also the long history of General Electric overall systems know-how—its broad background in the equipment, processes and materials to which you apply computer control.

Tomorrow's profits will come from today's combination of vision, equipment, and know-how. *Where do you stand?*

There are General Electric Sales and Application engineers in over one hundred offices throughout the nation to serve you. *Phone* the nearest General Electric Apparatus Sales Office, or *wire* General Electric Computer Department, 13439 North Black Canyon Highway, Phoenix, Arizona.

PROCESS CONTROL
AUTOMATED BY GENERAL ELECTRIC

Progress Is Our Most Important Product

GENERAL ELECTRIC

CPA-50 (9-60)

General Electric—a pioneer in computer systems for all phases of business, industrial, scientific, engineering, and financial endeavor.

CIRCLE 14 ON READER-SERVICE CARD

"Pushbutton" Ice Cream

PHILADELPHIA, PA.—Virtually complete automation of ice cream production has been in successful operation for more than half a year at the Boston ice cream plant of H. P. Hood & Sons. The system, conceived by an automation team of the Hood company and developed in cooperation with Brown Instruments Division of Minneapolis-Honeywell Regulator Co., (Wayne & Windrim Aves., Phila. 44, Pa.) as systems process engineers, incorporates a special analog-type computer; batch blending of all ingredients by coded punch cards; graphic representation and centralized control of the entire mix process, including pasteurization, homogenization and cooling processes; automatic HTST (pasteurization) system; and an automatic CIP (clean-in-place) system.

The *computer*, separate from the control system, mathematically determines, in terms of simultaneous equations, how much of an ingredient is required for a given formula, and digitally converts this information into pounds (on a coded punch card) for translation by the batch blending system. The mix for a given formula must be recalculated daily due to unpredictable fluctuations in butterfat and non-fat content of ingredients. The formula, resolved by the computer in 50 msec, accurate to within ±0.02 full scale, is displayed on a digital indicator and manually coded on the punch card.

The *punch card* is inserted in an instrumented console designed by Pottermeter Co. (Route #22, Union, N. J.) which contains 11 contacts serving as the output control, turning the batching operation on and off, energizing pumps and valves associated with unloading of ingredient storage tanks, and loading the blending tanks. Key to the measuring ingredients into the tanks is a turbine-type flowmeter.

The *graphic console*, besides containing controllers and indicators, serves also as the nerve center for starting the automatic CIP and HTST systems.

Automation has boosted production capacity by 70%—nobody has been laid off.

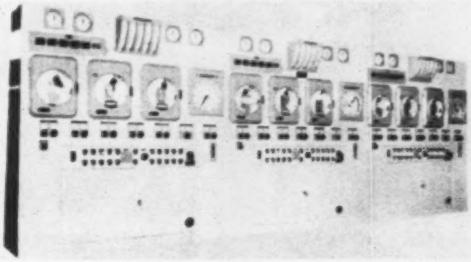
FOR MORE INFORMATION CIRCLE 167 ON READER-SERVICE CARD

ICS NEWS

MINNEAPOLIS-HONEYWELL has concluded a worldwide licensing agreement with Continental Oil Co. to manufacture and market a new electromechanical system for controlling corrosion. This "Anotrol" system develops a "passive film" on the internal surfaces of metal vessels and makes them resistant to such chemicals as sulphuric acid; phosphoric and nitric acids; sodium and potassium hydroxide; aluminum sulphate; and ammonium nitrate. Rubicon Div. in Philadelphia will handle the system. (Ridge Ave. at 35th St., Phila. 32, Pa.)

FOR MORE INFORMATION CIRCLE 168 ON READER-SERVICE CARD

HAGAN CHEMICALS & CONTROLS (Box 1346, Pittsburgh 30, Pa.) has custom-designed and manufactured the illustrated panel for the Bataan (Philippine Islands) power plant of a U. S. oil company. The panel will control three multiple-fuel-fired, 100,000-lb/hr steam-generating units, utilizing refinery gas, fuel oil, and fluid asphalt.



FOR MORE INFORMATION CIRCLE 169 ON READER-SERVICE CARD

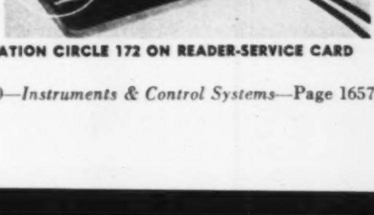
CONTROL CORP., a subsidiary of **CONTROL DATA CORP.** is building a new electronic data-logging system for Boston Edison Co.'s Mystic Station. The system will read 140 electric meters once an hour and type the results on a station log sheet. Control Corp. is located at 501 Park Ave., Minneapolis 15, Minn.

FOR MORE INFORMATION CIRCLE 170 ON READER-SERVICE CARD

BENSON-LEHNER (1860 Franklin St., Santa Monica, Calif.) has delivered the first drum-type Large Area Record Reader to Systems Development Corp. Capable of handling charts up to 48" x 50", the reader holds the chart or map on a rotatable cylinder.

FOR MORE INFORMATION CIRCLE 171 ON READER-SERVICE CARD

DURANT MFG. CO., 1981 North Buffum St., Milwaukee 1, Wis., has supplied the illustrated electric counter (Model "SP-MF" Electric Predetermined Counter) mounted on a high-speed Stator Winder. It shuts off the machine when the exact number of turns have been made.



FOR MORE INFORMATION CIRCLE 172 ON READER-SERVICE CARD

NEW APPLICATIONS

Solid-State Supervisory Control

LOS ANGELES, CALIF.—General Electric Company has produced a new supervisory system with plug-in cards utilizing transistors and diodes. The equipment is designed to operate on any two-way communication channel, including low-cost telegraph-grade leased wires.

Using GE's proved space-code the master station sends signals to remote stations in the form of pulses and pauses with operating intelligence carried by the pauses. Each control point has its own code. Lamps indicate when the code has been established between the master station and the remote station. Should enough distortion occur to add or subtract a pulse, the equipment locks out and resets itself.

The system, which is fully compatible with conventional relay-type remote units, is finding its first applications in Colorado Central Power Company's power generating station, and for control of substations by Western Massachusetts Electric Company.

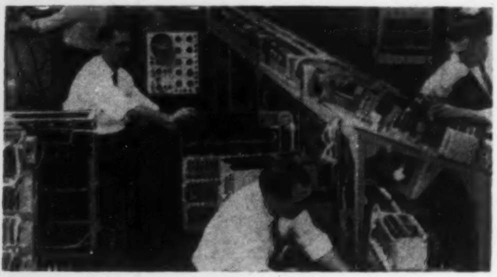
More information can be had from General Electric Co., 3325 Wilshire Blvd., Los Angeles 5, Calif.

CIRCLE 173 ON READER-SERVICE CARD

DATEX CORP. (1307 S. Myrtle Ave., Monrovia, Calif.) is building a river-monitor telemetering system for the Ohio River Valley Sanitation Commission which will digitize and record pH, conductivity, temperature, dissolved oxygen, dissolved chloride, and oxidation-reduction potential, upon receiving information from 40 remote transmitting stations along the Ohio River.

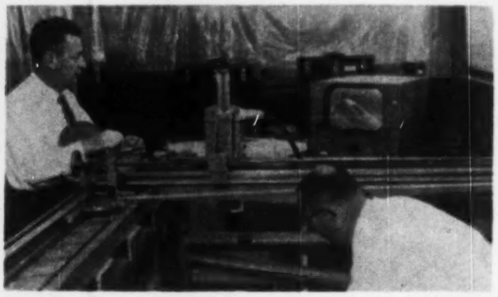
CIRCLE 174 ON READER-SERVICE CARD

BURROUGHS CORP. will have delivered nearly 50 electronic sorter-readers to some 25 banks before the end of the year.



SAMA has issued a Loan Film Directory listing 16-mm motion pictures and 35-mm stripfilms. The directory can be obtained free, upon request, by writing to SAMA, 20 North Wacker Dr., Chicago 6, Ill.

KINTEL DIV. of **COHU** Has supplied the ITV-system around which the Quality Control Dept. of Convair-San Diego Div. of General Dynamics has built a "universal inspection machine" used in checking large mechanical sections. Savings from 40 to 70% are claimed. (KINTEL Div., 5725 Kearny Villa Rd., Box 623, San Diego 12, Calif.)

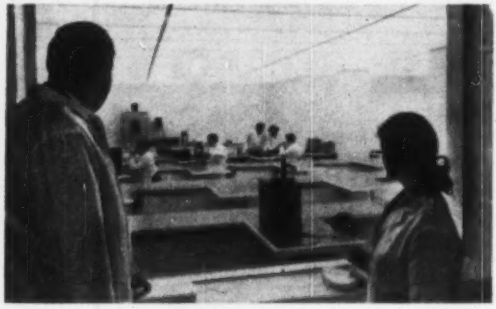


CIRCLE 175 ON READER-SERVICE CARD

NILSEN MFG. CO., 23 Church St., Addison, Ill., has found many new useful applications for its Variogon phase-shifter transducers, originally developed for radar ranging systems. Applications include: measuring angular motion and distance, studying frequency modulation, sine/cosine generation, industrial measurement/control, missile guidance/tracking, navigation, etc.

CIRCLE 176 ON READER-SERVICE CARD

GE's Lamp Div. (Nela Park, Cleveland 12, Ohio) has supplied and installed the 300-footcandle lighting system behind the vinyl-plastic ceiling in Hickok Electric's White Room, where meters for critical applications such as in aircraft, missiles, and space vehicles are assembled with great efficiency.



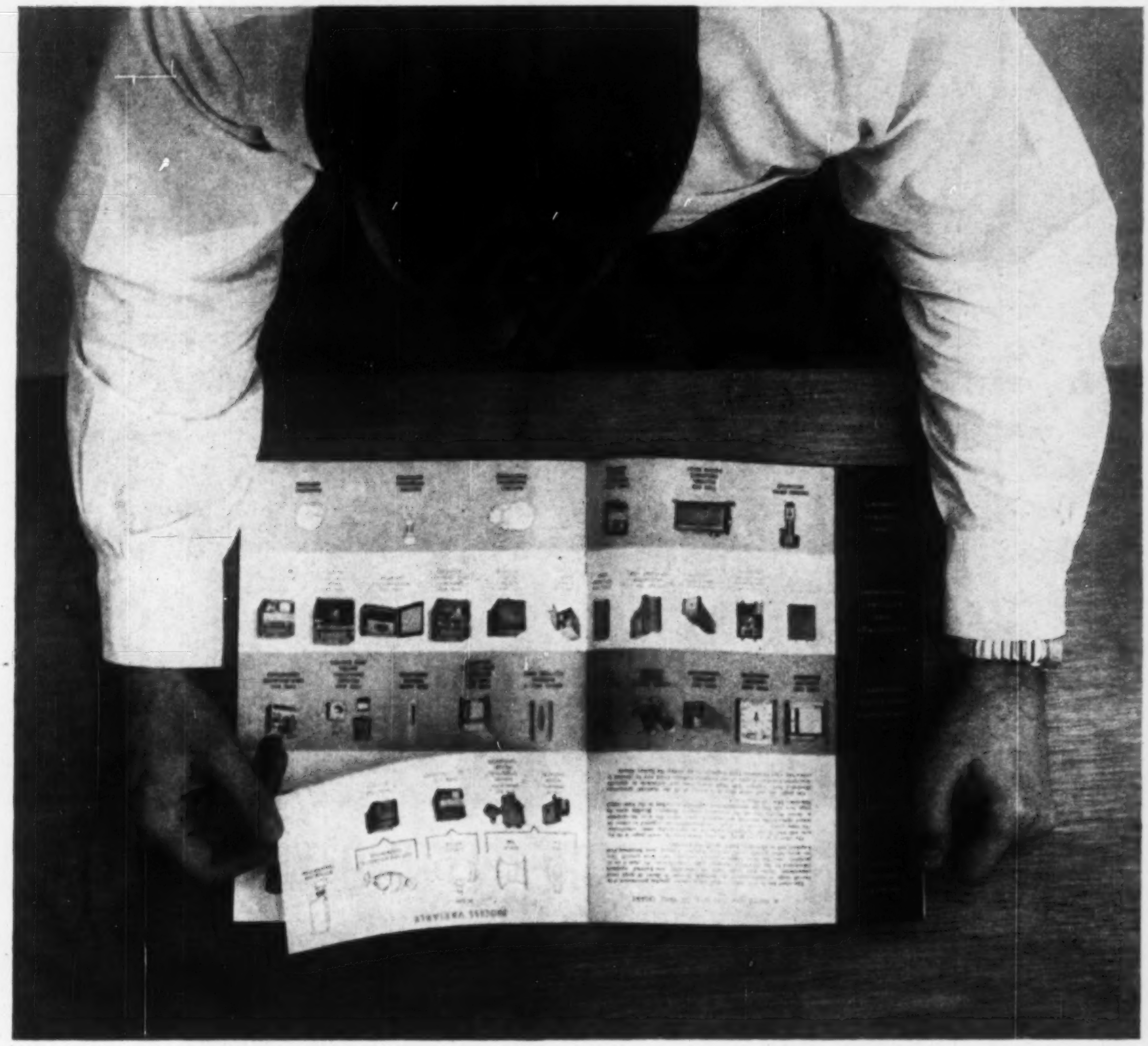
CIRCLE 177 ON READER-SERVICE CARD

ASSEMBLY PRODUCTS, Chesterland, Ohio, has built a new pressure-monitoring system for the East Ohio Gas Co. which will provide instant warning of abnormal gas pressures at 700 monitored points in the distribution system. Meter relays will trigger the alarms over telephone lines.

CIRCLE 178 ON READER-SERVICE CARD

MINNEAPOLIS-HONEYWELL has concluded an exclusive world-wide licensing agreement with Continental Oil Co. to manufacture and market the new *Anotrol* system for controlling corrosion, working on the principle of a d-c current being passed through the corrosive liquid to the vessel, whereby a "passive film" is developed.

WHAT'S THE HARDWARE SITUATION IN ELECTRONIC PROCESS CONTROL?



THIS NEW BOOKLET SHOWS YOU

Here, in concise, graphic form, is the whole array of Swartwout Autronic® instrumentation, industry's most comprehensive system of electronic process controls. Here is a unique presentation that shows you at a glance the diversity of equipment available to you, from sensor to actuator, for any given variable. Whether you're pondering a simple flow-control set-up or an interlocked multi-loop system, Swartwout has the hardware for the job—and this booklet will give you the specifics. To get a copy, just write for Bulletin A-913, "A Functional Guide to Autronic Control Equipment." SWARTWOUT DIVISION, CRANE CO., *Hooksett Industrial Park, Manchester, New Hampshire.*

CIRCLE 15 ON READER-SERVICE CARD

IMPERIAL
Engineering and Data File

IMPERIAL HI-SEAL AT A GLANCE . . .
. . . leakproof butt joints
shortest tube bends
saves space
holds pressures to 75,000 psi
temperatures to 1400 degrees
withstands extreme vibration

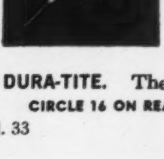
THE MOST VERSATILE TUBE FITTING YOU CAN USE!

Now it's official. U. S. Patent No. 2,934,362 — just issued — recognizes seven claims for the only true butt joint tube fitting on the market. Imperial Hi-Seal is available in a variety of types that meet unusual pressure, temperature, vacuum and vibration conditions. And Hi-Seal allows bends closer to the fitting, making possible more compactness than ever before — saves space, saves tubing. All this *plus* make-and-break convenience.

Here are some of the variations that make Hi-Seal so versatile:

FILTER TEE. A highly efficient, easily installed blow-off type filter with sintered wire element. Standard filtration rating of 5 microns filters dust and impurities from gases for accurate instrument readings. For use in chromatograph analyzers and other gas analyzers, separation of water particles from oil and for protection of air activated instruments.

BRAZE-SEAL. Withstands pressures and temperatures that previously required a welded joint. Special alloy brazing rings for temperatures as high as 1400°F.



THERMOCOUPLE. Provides the advantages of higher pressures and temperatures, plus the positive make-up obtainable with Hi-Seal fittings. Also available with Teflon sleeve to permit readjustment to any depth.

DURA-TITE. The most effective port seal for tube fittings. No seeping — even at pressures up to 20,000 psi. Withstands higher temperatures than O-Rings.

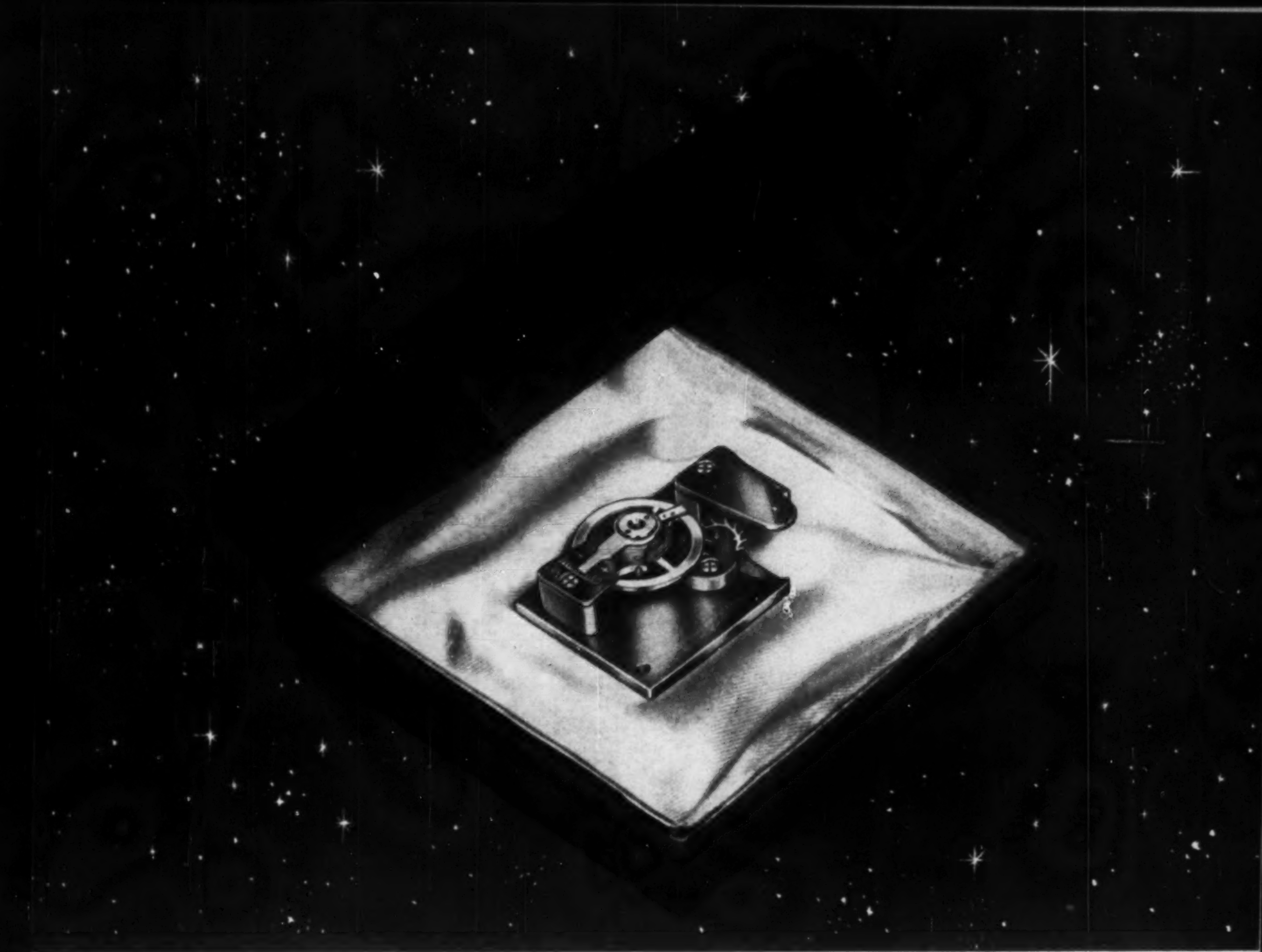
Hi-Seal fittings are furnished in steel, stainless, brass and aluminum as stock items — also titanium, tantalum, Monel, Penton, Teflon and other metals and plastics to order. Available in a complete range of styles and sizes.

Hi-Seal offers further proof that Imperial is the company *with a habit of leadership.*

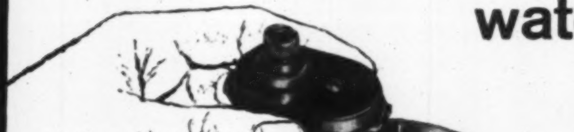
IT'S IN THE BOOK
Comprehensive data is furnished in the new Hi-Seal Catalog No. 3108 — the catalog that serves as an engineer's handbook as well. Send for your copy today.

THE IMPERIAL BRASS MFG. CO.
Dept. ICS-100, 6300 West Howard Street
Chicago 48, Illinois

CIRCLE 16 ON READER-SERVICE CARD



This "jeweled" escapement brings you fine watch quality in chart drives



Now, for the first time you get the extra value of a jeweled movement. This superior construction makes Rockwell chart drives more accurate and sensitive than ordinary chart drives. It requires less power to drive and is extremely durable since there are seven hard jeweled surfaces to overcome friction and wear.

You can use these jeweled movement chart drives *with profit* to power all your recording instruments. They will adapt into practically any instrument case. Speed changing turrets (see left) permit varying rotation rates at will. Write for bulletin. Rockwell Manufacturing Company, Dept. 58-K, Pittsburgh 8, Pa. In Canada, Rockwell Manufacturing Company of Canada, Ltd., P.O. Box 420, Guelph, Ontario.

See how easy it is to convert to seven different rotation rates

The main arbor on the basic chart drive has a rotation rate of seven days. Economical snap on turrets convert this rate to 8 day, 15 day, 16 day, 24 day, 30 day, 31 day and 24 hour rotation. No tools are required and you can even change chart rotation without removing the drive from the instrument.

JEWELED CHART DRIVES

another fine product by

ROCKWELL

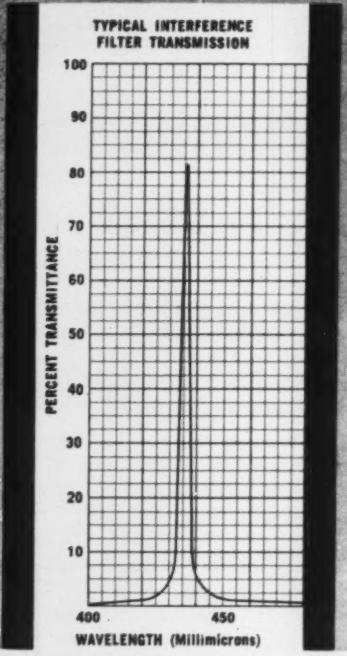
CIRCLE 17 ON READER-SERVICE CARD

now from Librascope:

NARROW-BAND INTERFERENCE FILTERS

...with a new approach to side-band problems

Recent achievements at Librascope's Applied Research Center make it possible for you to now order high-precision, multilayer, narrow-band interference filters...custom-made to your specified wavelength, side-band requirement, and detector's spectral characteristics. Greater than 70% transmission and a half bandwidth of approximately 1% at specified peak wavelength. Delivery from stock: set of 8 filters uniformly distributed over visible spectrum...as well as mercury and sodium lines. Send your requirements for quotation today.



BURBANK BRANCH
LIBRASCOPE DIVISION
GENERAL PRECISION, INC.
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CIRCLE 18 ON READER-SERVICE CARD

ICS STOCK REPORT

Further information may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

NEW YORK STOCK EXCHANGE

PRICE RANGE FOR 1960 THRU SEPTEMBER 23, 1960

	High	Low	Price As Of 9/23/60
ACF Industries	52	41 1/8	41 3/8
Aeroquip Corp.	40 5/8	23 5/8	25 1/2
Allis Chalmers	40	25 1/8	25 1/4
American Chain & Cable	51 3/4	42 3/8	44 1/4
Amer. Mach. & Foundry	74 3/4	49 1/2	60 3/4
Amer. Mach. & Metals	58 ./4	33	33
American Optical	67	43 1/4	53
Amer. Tel. & Tel.	97 5/8	79 7/8	91 7/8
Ampex Corp.	42 1/4	25 3/4	25 3/4
Aro Equipment	25 7/8	19	21 5/8
Bausch & Lomb Optical	58 7/8	34 1/2	39 5/8
Beckman Instruments	103 3/4	62 1/2	86 1/2
Bell & Howell	57 1/2	37 5/8	44 5/8
Bendix Aviation	74 1/2	57 1/2	62 1/4
Boeing Airplane	35 3/4	23	29 1/2
Bullard	17 7/8	11	12 1/8
Bulova Watch	23 3/4	14 1/8	19 1/8
Burroughs	40 3/8	28 3/4	32 3/8
Carborundum	49 7/8	41 1/4	42 3/4
Cinn. Milling Machine	38 1/2	26 3/4	30 1/4 Bid 30 3/4 Asked
Clevite	72 1/2	42	52 1/2
Columbia Broadcasting Sys.	45 1/4	36 5/8	39 1/8
Consol. Electronics	60 3/4	42 1/4	48 5/8
Corning Glass	186	124	164 1/2
Curtiss Wright	31 1/8	16 1/2	17 1/2
Cutler-Hammer	96	70	70
Daystrom	49 3/8	31 3/4	33 1/4
Douglas Aircraft	42 3/8	27	28 1/4
Eastman Kodak	136 1/4	94	114
Eaton Mfg.	46 7/8	30 1/4	31 1/8
Electric Auto-Lite	54 1/2	44 1/2	46 1/4
Elgin Watch	19 1/8	11 1/2	13 3/4
Emerson Electric (new)	50	33	42 1/4
Engelhard Industries	23	19 1/4	20 1/4
Food Mach. & Chem	58 1/8	44 1/2	51
Garrett	54 7/8	42 1/8	52 1/4
General Controls	29 5/8	18 1/2	18 5/8
General Dynamics	53 3/8	34 1/8	34 1/8
General Electric	99 7/8	75 1/2	75 1/2
General Instruments	50 3/8	22 1/2	34 3/8
General Mills	31 7/8	23 7/8	30
Gen. Precision Equip.	66 5/8	44 1/4	48 1/2
Gen. Railway Signal	36 7/8	24 3/4	26 1/4
Gen. Tel. & Elect. (new)	34 1/8	27	27 1/2
General Time (new)	33 1/8	16 5/8	16 3/4
General Tire & Rubber	81 3/8	46 1/2	46 1/2
International Bus. Mach.	550	407 1/4	511
International Resistance	41 5/8	18 1/4	32 1/4
Internat'l. Tel. & Tel.	46 3/4	32	38 3/8
I-T-E Circuit Breaker	44 1/4	19 7/8	21
Lear Inc.	23 1/2	13 5/8	16 1/4
Litton Industries	96	57 5/8	71 7/8
Lockheed Aircraft	32 7/8	18 5/8	23 7/8
Magnovox	55	31 3/4	43 3/4
Mallory	50 1/4	38 1/2	39 1/2
Minneapolis-Honeywell	178 3/4	123 5/8	135
Minnesota Mining & Mfg.	88	65	66 1/4
Motorola (new)	98	67 1/2	67 1/2
National Acme	54 3/4	42 1/4	44 1/2
National Cash Register	70 7/8	54 5/8	55
Neptune Meter	34 3/8	24 3/4	26 1/4
North American Aviation	45 1/4	29 5/8	40 1/2
Northrop Aircraft	42 1/8	24 3/4	36 7/8
Otis Elevator	58 1/2	36 3/4	50
Philco Corp.	38 1/4	21 1/4	21 1/4
Radio Corp. of America	78 3/8	53 1/4	54
Raytheon Mfg.	53 3/8	34 1/2	34 1/2
Reliance Electric	68 5/8	46 1/2	46 1/2
Rheem Mfg.	28 7/8	15 5/8	15 7/8
Robertshaw Fulton	55	36	37 1/2
Royal Mc Bee	21 3/8	13 1/4	14
Sangamo Electric	21 1/2	15 1/4	16
Siegler Corp.	43	29 1/4	30 1/8
Sperry Rand	26 1/4	20 1/8	20 3/8
Square D	37 7/8	25 1/2	27 1/4
Standard Kollsman	30 1/2	12 5/8	21 1/4
Starrett (L.S.)	20	16	19
Stewart-Warner	33 1/2	23	25 1/2
Telautograph	24 1/2	6 7/8	19
Texas Instruments	256 1/4	154	177 1/4
Thompson-Ramo-Wooldridge	67 1/2	46 7/8	54 3/4
Tung-Sol Electric	40 1/2	28	30
Underwood Corp.	57	24 3/4	46 3/8
Union Carbide Corp.	148 1/2	110 1/2	111 1/2
United Shoe Machinery	64 3/8	50	58 1/2
Varian Associates	67 1/2	39 3/4	43 5/8
Wallace & Tiernan	69 1/4	41	61
Western Union	57	41 3/4	45 5/8
Westinghouse Air Brake	32 5/8	23 3/4	23 1/2
Westinghouse Electric	64	45 1/2	48 5/8
Worthington Corp.	66	44 7/8	44 7/8

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(1) Not Traded - Bid & Asked

These prices and price ranges are given as printed in the Wall Street Journal.

AMERICAN STOCK EXCHANGE

PRICE RANGE 1960 THRU SEPTEMBER 23, 1960

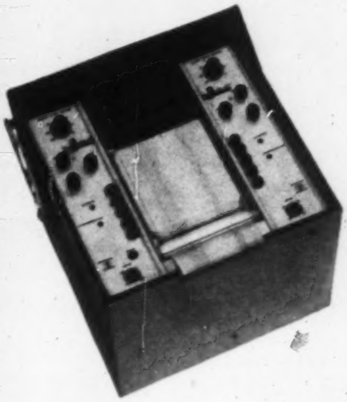
	High	Low	Price As Of 9/23/60
American Meter	52	41 1/2	41 1/2
Barry Controls "B"	25 1/2	16 1/4	17 5/8
Belock Instruments	25 3/8	13 1/8	18 3/4
Benrus Watch	8 7/8	5 3/8	7 1/2
Breeze Corp.	8 5/8	4 5/8	5 1/8
Clark Controller	23 5/8	18 5/8	18 3/4
Clarostat Mfg.	16 3/8	9 7/8	12 3/4
Clary Corp.	11 1/2	6 3/4	10
Cubic Corp.	69	48 1/2	57 1/8
Dynamics Corp. of Amer.	13 3/4	8 5/8	8 5/8

continued on page 1664

keep an accurate graphic record

OF RESEARCH, DESIGN, TEST DATA

two channels



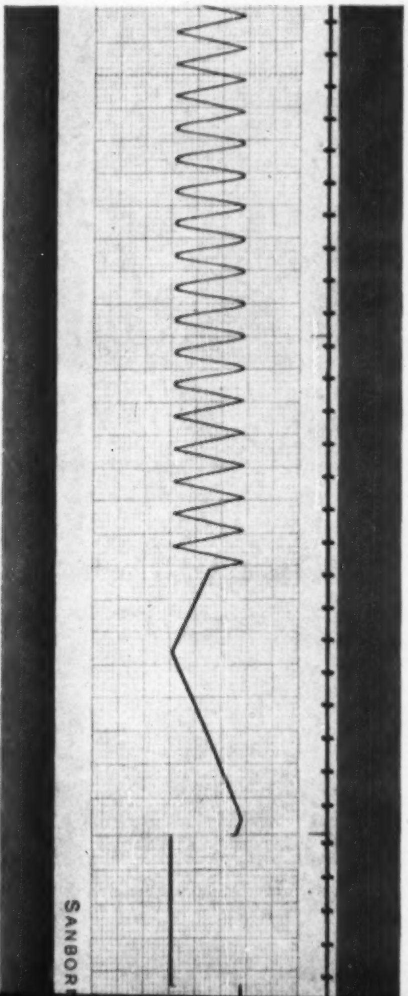
For General Purpose
DC Recording — Model 320

For recording *two variables* simultaneously, the Model 320 provides a versatile, transistorized amplifier for each input signal. The rugged 2-channel recorder assembly has heated stylus recording on two *50 mm wide* rectangular coordinate channels, 4 pushbutton chart speeds, and 6 inches of visible chart. The Recorder can be placed vertically, horizontally or at a 20° angle.

MODEL 320 SPECIFICATIONS

Sensitivity: 0.5, 1, 2, 5, 10, 20 mv/mm and v/cm
Frequency Response: 3 db down at 125 cps, 10 mm peak-to-peak
Common Mode Voltage: ±500 volts max.
Common Mode Rejection: 140 db min. DC
Calibration: 10 mv internal ±1%
Output Connectors for each channel accept external monitoring 'scope or meter
Price: $1485

NEW SANBORN PORTABLE DIRECT WRITING RECORDERS FOR IN-PLANT, LABORATORY OR FIELD RECORDING



Two models of this 21 lb. brief case size recorder are available — Model 301 for AC strain gage recording, Model 299 for general purpose DC recording. Both provide immediately visible, inkless traces by heated stylus on 40 division rectangular coordinate charts . . . frequency response to 100 cps . . . 5 and 50 mm/sec chart speeds . . . approx. 4 inches of record visible in top panel window.

single channel

MODEL 301 SPECIFICATIONS

The amplifier section of the Model 301 is an all-transistorized carrier type with phase sensitive demodulator. The power supply and internal oscillator circuits are also transistorized.
Sensitivity: 10 uv rms/div (from transducer)
Attenuator Ratios: 2, 5, 10, 20, 50, 100, 200
Carrier Frequency: 2400 cps internal
Transducer Impedance: 100 ohms min.
Calibration: 40 uv/volt of excitation
Output Connector: for external monitoring 'scope or meter
Price: $750

MODEL 299 SPECIFICATIONS

Combines the dependability of transistors with the high input impedance of vacuum tubes for reliable broad-band DC recording.
Sensitivity: 10, 20, 50, 100, 200, 500 mv/div and 1, 2, 5 and 10 v/div
Input Resistance: 5 megohms balanced each side to ground
Common Mode Voltage: ±2.5 volts max. at 10 mv/div sensitivity increasing to ±500 volts max. at other sensitivities
Common Mode Rejection: 50:1 most sensitive range
Calibration: 0.2 volt internal ±1%
Output Connector: for external monitoring 'scope or meter
Price: Model 299 (with zero suppression) $700
Model 299A (without zero suppression) $650

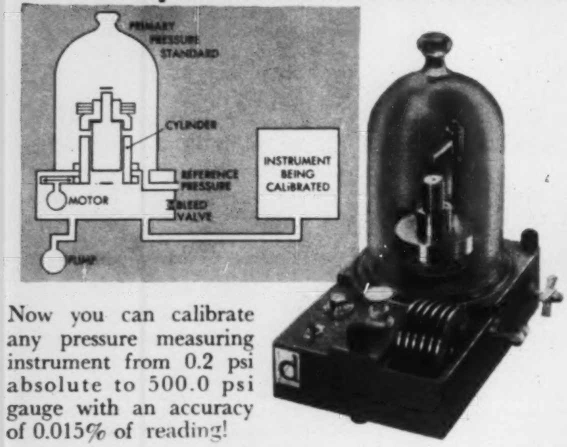
All prices are F. O. B. Waltham, Mass., within continental U. S. A. and are subject to change without notice.

Contact your Sanborn Sales-Engineering representative for complete information, or write the main office in Waltham. Sales-Engineering representatives are located in principal cities throughout the United States, Canada and foreign countries.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Mass.

CIRCLE 19 ON READER-SERVICE CARD

NEW! PRIMARY PRESSURE STANDARD
with Cyclic Bi-directional Rotation



Now you can calibrate any pressure measuring instrument from 0.2 psi absolute to 500.0 psi gauge with an accuracy of 0.015% of reading!

- Exclusive cyclic bi-directional rotation of cylinder minimizes lift error
- Four pressure ranges
- Use any reference pressure from zero to one atmosphere absolute
- Self-contained pressure source provides pressure up to 15 psi

Write for Technical Bulletin on Primary Pressure Standard.

DYNAMETRICS CORPORATION
Northwest Industrial Park, Dept. 18. Burlington, Mass.
CIRCLE 20 ON READER-SERVICE CARD

AMERICAN STOCK EXCHANGE

continued from page 1662

El-Tronics	1 7/8	1 1/8	1 1/4	
Electronics Corp. of Amer.	19 1/2	8 1/8	12 1/8	
Fairchild Camera & Instrument	201 3/4	110 1/4	169 3/4	
Giannini Controls	68 3/4	41 3/4	52 1/2	
Globe-Union	34 3/4	24	24	
Hazeltine Corp.	31 1/2	22 1/8	22 1/8	
Loral-Electronics	105 3/4	34 5/8	79	
National Research	23 1/8	14 7/8	16 1/8	
New Haven Clock	2 7/8	1 1/4	1 5/8	
Nuclear Corp. of Amer.	5 1/8	2 1/8	3 7/8	
Philips Electronics, Inc.	47 3/8	31 1/2	37 1/2	
Pneumatic Scale	59 3/4	37 1/4	37 1/4	Bid
			(1) 39	Asked
Polarad Electronics (new)	36 5/8	23 5/8	26 5/8	
Servo Corp. of Amer.	24 1/2	13 1/8	13 1/8	
Servomechanisms	16	8 1/8	9 1/2	
Statham Instruments Inc.	40 1/4	27 1/8	34 1/2	
Textron Electronics	18 3/4	11 1/4	11 5/8	
Victoreen Instrument Co.	17 1/2	9 3/4	14	
Waltham Prec. Instr. Co.	3 1/2	2	2 1/4	

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(1) Not traded - Bid & Asked

OVER THE COUNTER

	Quotation As of September 23, 1960	
	Bid	Asked
Aerovox Corp.	9 1/4	10
Argus Corporation	31	32
Black Sivalls & Bryson Inc.	12 1/4	13 1/2
Computer Systems	13 1/2	15
Eitel Mc Cullough	23 1/4	24 1/4
Electro Instruments	29	32
Electronics Associates	29	31
Erie Resistor Corporation	8	8 5/8
Fisher Governor Co.	15 3/4	16 3/4
Foxboro Company (new)	46	48
Hagan Chemicals & Controls	40 1/2	42 1/2
Industro Transistor	6 1/2	7 1/4
Liquidometer Corp.	20 1/2	22
W. L. Maxson	8 7/8	9 1/2
Penn Controls	21	22 1/2
Speer Carbon, Inc.	23 1/2	24 3/4
Sprague Electric	46	48 1/2
Taylor Instruments (new)	35 3/4	37
Telechrome Mfg. Corp.	11 1/4	12 1/4
Telecomputing Corp.	7 1/4	7 7/8
Vitro Corp. of Amer.	11 7/8	12 3/4

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THERMOCOUPLES FOR PROCESS INDUSTRIES
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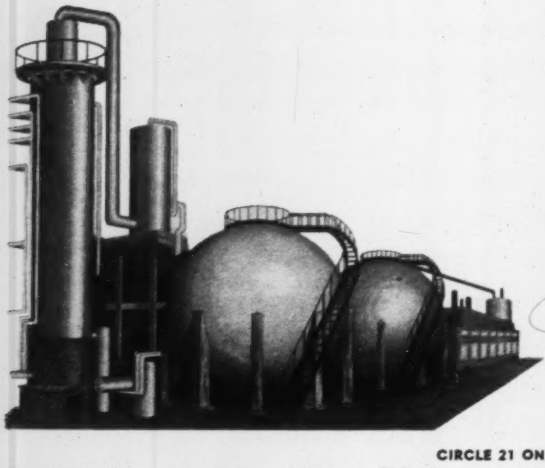
LABORATORIES

Wherever surface and inwall temperature measurements are required with:
PRECISE JUNCTION LOCATION
MINIMUM HEAT FLUX DISTORTION
RAPID-ACCURATE RESPONSE



For more information, write to:
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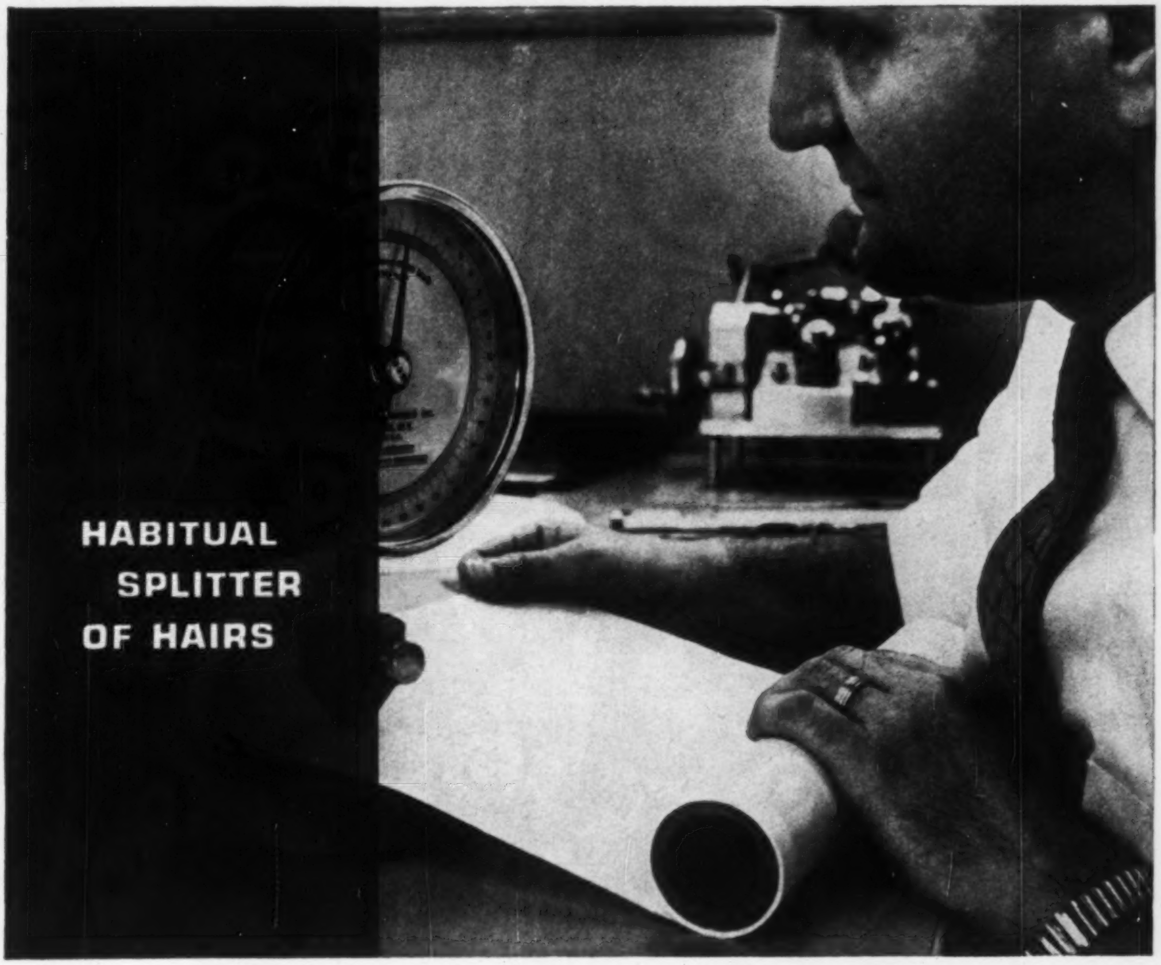
A DIVISION OF AMERICAN-Standard
Dept. AE-5, 369 Whisman Road, Mountain View, California
CIRCLE 21 ON READER-SERVICE CARD



. . . because a mil can matter greatly in
RECORDING CHART PERFORMANCE

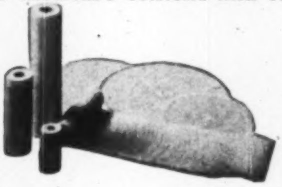
Even a fraction of a mil can bulk large in the thickness of a recording chart. That's why John Mazurowski and his thickness micrometer are so important to chart users.

A process change in an eastern oil refinery, for example, called for a longer strip chart in a temperature recorder — but the diameter of the roll could be no bigger than before. GC engineers solved this problem by working with our paper mills to reduce chart paper thickness from 0.00275" to 0.0019" while preserving strength and flexibility.

To make sure our charts meet the requirements of your instruments, GC engineers test paper stock for moisture content and tear-strength, too. This rigid inspection of paper that is produced exactly to GC specifications is a major reason why GC Recording Charts consistently fulfill their promise of accurate performance.

Other reasons for GC quality include our special formula printing inks, our exclusive innovations in plate-making and printing, and the scrupulous humidity control maintained throughout our manufacturing and storage areas.

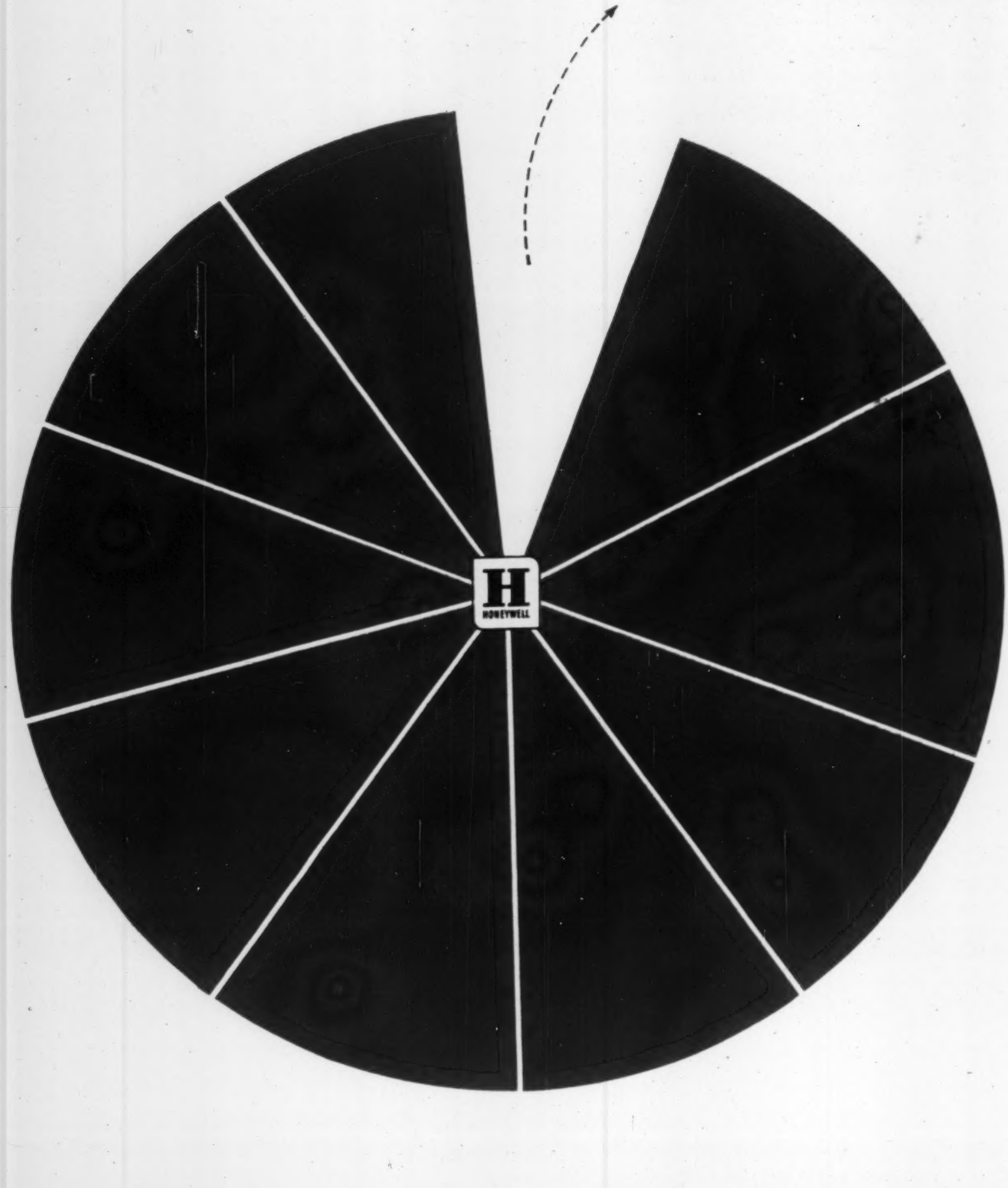
GC Recording Charts have become standard equipment in more than 5,000 plants today. We stock more than 15,000 different charts—and will design and produce accurate special-purpose charts. Send for our 1960 Stock List — and for sample charts.



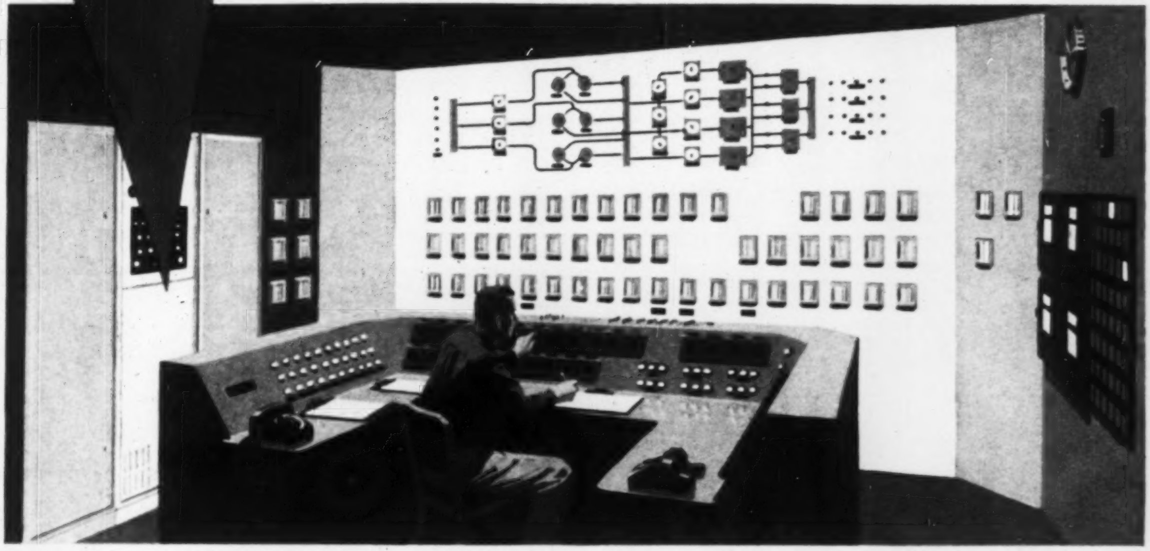
GC RECORDING CHARTS

CIRCLE 22 ON READER-SERVICE CARD

A COMPUTER IS ONLY



PART OF A PROCESS CONTROL SYSTEM



You hear a lot about industrial process computers these days. As processes get bigger, faster and more complex, computers are being used as the reins as well as the brains—for control as well as data reduction—in fields as diverse as ice cream making and petroleum refining.

The Big Picture. But like the human brain, a computer cannot work independently. It must receive raw information from sensory instruments. Where automatic control is involved, it must transmit its logic to "muscle" instruments which translate decisions into action. The computer is part of a system, and, like the human body, the system functions effectively only when all of its parts are perfectly coordinated. In Honeywell systems, this compatibility of *all* system components is built in, for all Honeywell instruments and controls are *made* to complement each other.

Process Experience plus Computer Know-How. Equally important, a computer must be properly applied. Computers are "illiterate." They must be told what to do and how to do it by men who know. In engineering a computer-directed instrumentation system that will be precisely matched to your needs, Honeywell systems engineers draw on more than 75 years of measurement and control experience.

Single-Source Responsibility. Honeywell offers you a single contract covering your entire system. You get economy, convenience, simplified training of personnel, economical stocking of parts and accessories—*all* the advantages of single-source purchasing. And you get the only truly complete computer control package available from a single source.

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75th YEAR PIONEERING THE FUTURE

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SINCE 1885

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•MACHINING AND PROCESS CONTROL
•COUNTING
•BATCHING
•SORTING
•MIXING
•WINDING
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...or any other physical process that can be electrically digitized.

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HIGH-SPEED,
SOLID-STATE,
PRESET COUNTER

PRESET COUNTER
ERIE PACIFIC

MODEL 300T

The completely transistorized Model 300T industrial counter is rugged, dependable and low-cost control instrumentation that is ideal for every use requiring a preset counting device. Modular design minimizes maintenance time and steel construction permits mounting directly on controlled machine. Modules can be easily modified for special applications. The 300T is a truly remarkable instrument that deserves your serious consideration.

Send today for complete technical information.

SPECIFICATIONS
Speed: 6,000,000 counts per minute
Range: 1 to 9,999 standard. 5 to 8 decades available
Reset: Automatic, manual, local or external
Size: 3½" high; 9½" wide; 14" deep (standard model)
Weight: Approx. 10 lbs.

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CIRCLE 24 ON READER-SERVICE CARD

ICS EVENTS

October 17-19

1960 Symposium on Adaptive Control Systems, Garden City Hotel, Garden City, Long Island, N. Y. For information write F. P. Caruthers, Specialties Inc., Skunks Misery Road, Syosset, N. Y.

October 19-21

Society for Experimental Stress Analysis 1960 Annual Meeting, Hotel Claremont, Berkeley, California. For information write R. F. Stredel, Jr., Engineering Design Dept., University of California, Berkeley 4, Calif.

October 19-26

INTERKAMA, 2nd International Congress & Exhibition for Instrumentation and Automation, Duesseldorf, Germany. For information write German American Chamber of Commerce, 666 5th Ave., N. Y. 19, N. Y.

October 26-27

1960 Computer Symposiums Applications Symposium, Morrison Hotel, Chicago, Ill. For information write Andrew Ungar, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

October 27-28

1960 Electron Devices Meeting, Shoreham Hotel, Washington, D. C. For information write H. W. Welch, Jr., I.R.E., 1 East 79th St., New York 21, N. Y.

October 27-29

Aircraft Electrical Society 1960 Industry Display, Pan Pacific Auditorium, Los Angeles, Calif. For information write McFadden/Charlesworth Co., Inc., 9171 Sunset Blvd., Los Angeles 46, Calif.

October 31-November 4

Current Developments in Automatic Data Processing Systems—Seventh Institute on Electronics in Management, American University, Washington, D. C. For information write Lowell H. Hattery, American University, 1901 F. St., N.W. Washington 6, D.C.

November 1-2

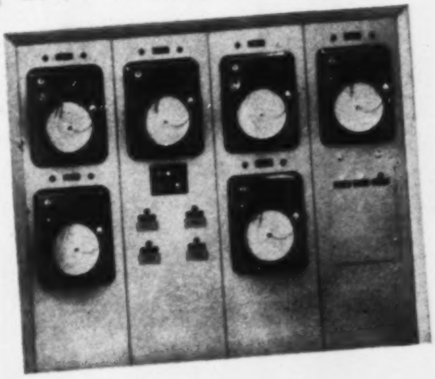
1960 Radio Fall Meeting of the Electronic Industries Association, Hotel Syracuse, Syracuse, N. Y. For information write J. A. Caffiaux, EIA Engineering Dept., Rm. 2260, 11 West 42 St., New York 36, N. Y.

November 14-16

12th Mid-American Electronics Conference, Hotel Muehlebach, Kansas City, Mo. For information write L. R. Crissmon, 10 Richards Rd., Kansas City, Mo.

American® Telemetering Equipment Means Operating Economy!

At this typical dispatching panel, one man does the work of many with American Telemetering and Telecounting equipment. At a central location, instantaneous, accurate flow and pressure readings are received from remote points and adjustments for load demands are made with remote-set controllers. Peak shaving can be performed with complete accuracy and confidence. Maximum gas sales to interruptible customers are assured.



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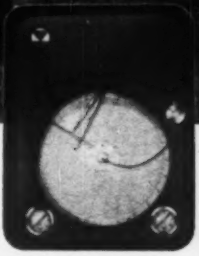
SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase, and Welded Steelcase Meters • American-Westcott Orifice Meters Instruments • Reliance Regulators • Apparatus • Valves

American Integrating Orifice Meters . . . Single, double and duplex-integrating models are available in a wide range of manometer types and working pressures.



American Series A-88 Controllers control flow, pressure, liquid level and other continuous process variables accurately, automatically and with a minimum of maintenance.

Whether your system is large or small, it will pay you to consult your nearest representative about the many economies American Telemetering Systems provide.

CIRCLE 25 ON READER-SERVICE CARD

8
10
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14
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16
IRON-CONSTANTAN TYPE J
DEGREES FAHRENHEIT
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NEW

WHEELCO "DOUBLE-O"

Behind this dial, Wheelco presents a *new* instrument line at industry's most attractive price . . . the Double-O Models Recording and Indicating Controllers. Wheelco has integrated the most popular and the same famous Wheelco quality features into one full-size (not a miniature) electronic potentiometer controller line. And now, a volume production savings is passed on to you. Write today for complete details.

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CIRCLE 26 ON READER-SERVICE CARD

ICS BOOKS

For more information on these books, or for publisher's book list circle number on reader-service card.

Analog Computation in Engineering Design, by A. E. Rogers and T. W. Connolly, [c1960] McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 450 pp., 9", clothbound $16.00. Two practical engineers show the techniques for using analog computers in solving problems of chemical processes and process controls, feedback control systems, nuclear reactors, and those involving statistical phenomena.

CIRCLE 179 ON READER-SERVICE CARD

Electronic Flash Photography, by Ralph L. Aspden [c1959] The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 192 pp., 8½", clothbound $8.50. The subtitle "a survey of principles and practical techniques in industry, research, and radiography" well describes the content of this book which includes a description of every type of commercially available flash equipment.

CIRCLE 180 ON READER-SERVICE CARD

Photoconductivity of Solids, by Richard H. Bube, [c1960] John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 461 pp., 9", clothbound $14.75. First book to offer a comprehensive analysis of the photo conductivity of solids. It also gives the correlation between photoconductivity and other similar phenomena in insulators and semi-conductors. Theoretical viewpoints of the mechanism of this phenomenon round out the interpretation.

CIRCLE 181 ON READER-SERVICE CARD

The Story of Chemistry, by George Lockemann, [c1959] Philosophical Library, Inc., 15 East 40 St., New York 16, N. Y., 277 pp., 7¼", clothbound $4.75. Book provides interesting reading on the history of chemistry as presented by one of Germany's leading organic chemists.

CIRCLE 182 ON READER-SERVICE CARD

Basic Electrical Measurements, Second Edition, by M. B. Stout, [c1959, 1960] Prentice-Hall, Inc., Englewood Cliffs, N. J., 571 pp., 9", clothbound $11.65. This first text in its field to stress problems offers extensive expansion of important topics, new statistical studies, and up-dating of material. Expanded topics include potentiometers (particularly the microvolt type), ac-dc transfer instruments, capacitance standards and bridges, etc.

CIRCLE 183 ON READER-SERVICE CARD

Free and Inexpensive Educational Aids, by Thomas J. Pepe [c1960], Dover Publications, 180 Varick St., New York 14, N. Y., 289 pp., 8", paperbound $1.25. More than 1500 items are organized into 59 categories covering such fields as mental health, first aid, language arts, wild life, childhood growth and development, science, social studies, arithmetic, etc.

CIRCLE 184 ON READER-SERVICE CARD

Fundamentals of Transistor Physics, by Irving Gottlieb, [c1960] John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y., 152 pp., 8½", paperbound $3.90. The author offers a thorough analysis of the action of semiconductors from the physics viewpoint. Includes recent developments such as the four-layer diode, the bilateral transistor, the Zener diode, the junction photodiode, the solar generator, the phototransistor, and the tunnel diode.

CIRCLE 185 ON READER-SERVICE CARD

Advances in Computers, Vol. 1, edited by Franz L. Alt, [c1960] Academic Press Inc., 111 Fifth Ave., New York 3, N. Y., 316 pp., 9", clothbound $10.00. First volume in a new series intended to occupy a position intermediate between a technical journal and a collection of handbooks.

CIRCLE 186 ON READER-SERVICE CARD

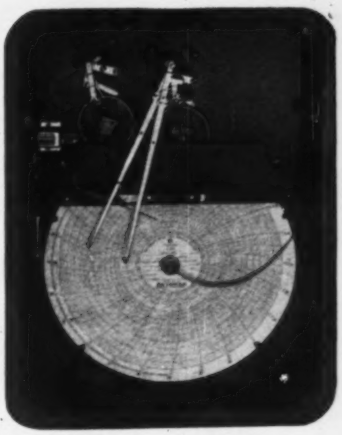
INSTRULAB'S
Temperature Compensated
evenvolt
Constant Voltage Unit

Replaces Batteries and All Standardizing Components Including Standard Cell in
POTENTIOMETERS
• CONTROLLERS • INDICATORS • RECORDERS

Mfg. By
INSTRULAB, INC.
1205 Lamar Street
Dayton 4, Ohio
Phone BA 3-2241

Outstanding FEATURES
- **Eliminates** batteries ...errors due to battery exhaustion
- **Reliable** construction...from quality components, long, trouble-free service
- **A Precise** voltage regulator . . . max. ±.04% for ±20% voltage variation
- **Quickly Installed**... Fits present instrument battery space.
- **No Tubes** to replace

CIRCLE 27 ON READER-SERVICE CARD



AMERICAN®
INTEGRATING
ORIFICE
METERS

American Integrating Orifice Meters provide more accurate measurement by the continuous multiplication of the square root of the measured differential by the square root of the absolute line pressure.

Single, double and duplex-integrating models available in a wide range of manometer types and working pressures. Dust-proof, die-cast aluminum cases... Gasclok and electric instrument chart drives. Also supplied with American Telecounter for remote readings.

Ask for Bulletin 401 for complete details.

AMERICAN®
METER COMPANY
INCORPORATED · ESTABLISHED 1836
General Offices: Philadelphia 16, Pa.
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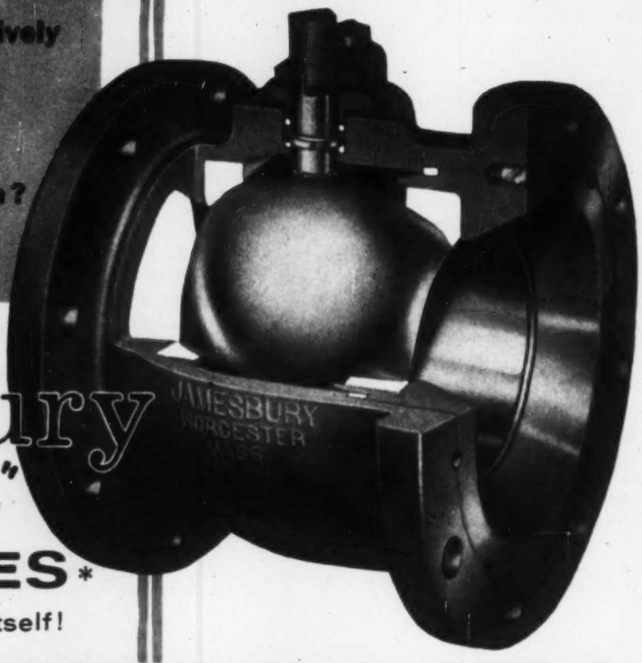
CIRCLE 28 ON READER-SERVICE CARD

Before Buying Any Valve

ASK THESE QUESTIONS

1. Will It Perform More Effectively In The Service?
2. Where Will It Save Money?
3. How Practical Is The Design?



jamesbury "Double-Seal"™ BALL VALVES*

As Versatile As Industry Itself!

PROVIDE THE RIGHT ANSWERS

1. The "Double-Seal" Ball Valve has PROVED more effective in handling a wider range of liquids and gases than any other valve.
2. The "Double-Seal" Ball Valve requires no lubrication. Special design permits valve stem to be removed for repacking while valve remains in line full-open or full-closed. Resulting savings on maintenance are significant.
3. The "Double-Seal" Ball Valve design is the original ball valve design engineered to give more control, full pipeline capacity and minimum friction loss.

JAMESBURY CORP., Worcester, Mass.

Distributors in Principal Cities

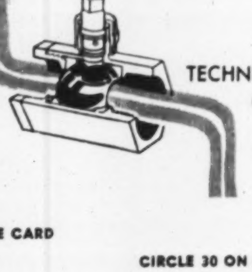
Widest Range of Sizes and Materials Available

METAL VALVES		PLASTIC VALVES	
TYPE	SIZES	TYPE	SIZES
Screwed End Flanged	¼" thru 3" ½" thru 10"	Screwed End Flanged	½" thru 3" ½" thru 4"

Jamesbury "Double-Seal" Ball Valves are available in Types 303, 316 and Alloy 20 Stainless Steels, Carbon Steel, Bronze, Ductile Iron, Aluminum and PVC. Other materials on special order.

Interchangeable seats and seals are available in "Teflon", Nylon, Buna-N, Neoprene, Hypalon and natural rubbers.

Pneumatic, Hydraulic and Electric Motor Operators to fit Remote Control Requirements.



COMPLETE
TECHNICAL INFORMATION
ON REQUEST

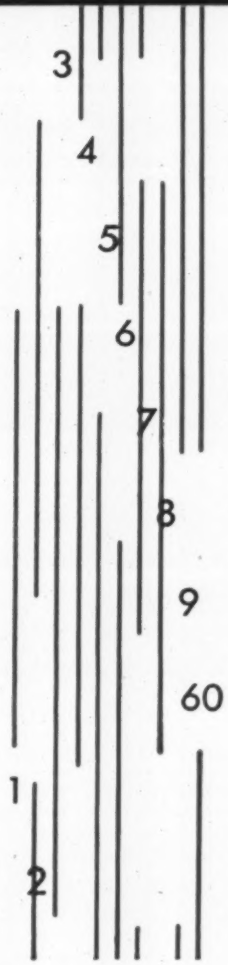
* PATENTED

31341

CIRCLE 29 ON READER-SERVICE CARD

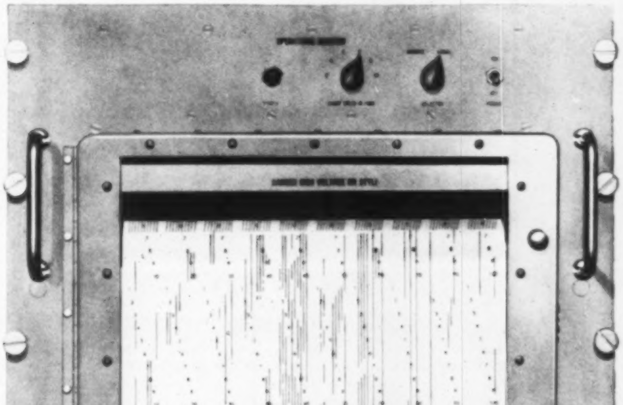
CIRCLE 30 ON READER-SERVICE CARD ⟶

verify events permanently in milliseconds



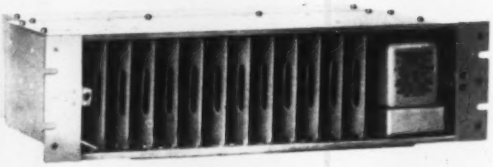
Brush Operations Monitors' response to signals is virtually instantaneous—less than 4 milliseconds. Multiple high-speed events are clearly defined from start to stop, on a common time base—and at rates up to 500 per second. Portable 30 channel or rack-mounting 100 channel models record sharp reproducible traces with fixed-stylus electric writing that provides the utmost in reliability. "Built-in" transistor switching to eliminate relays is optional. No direct writing recording system can match the capabilities of Brush Operations Monitors for industrial and military analysis and control. Write for complete specifications and application data.

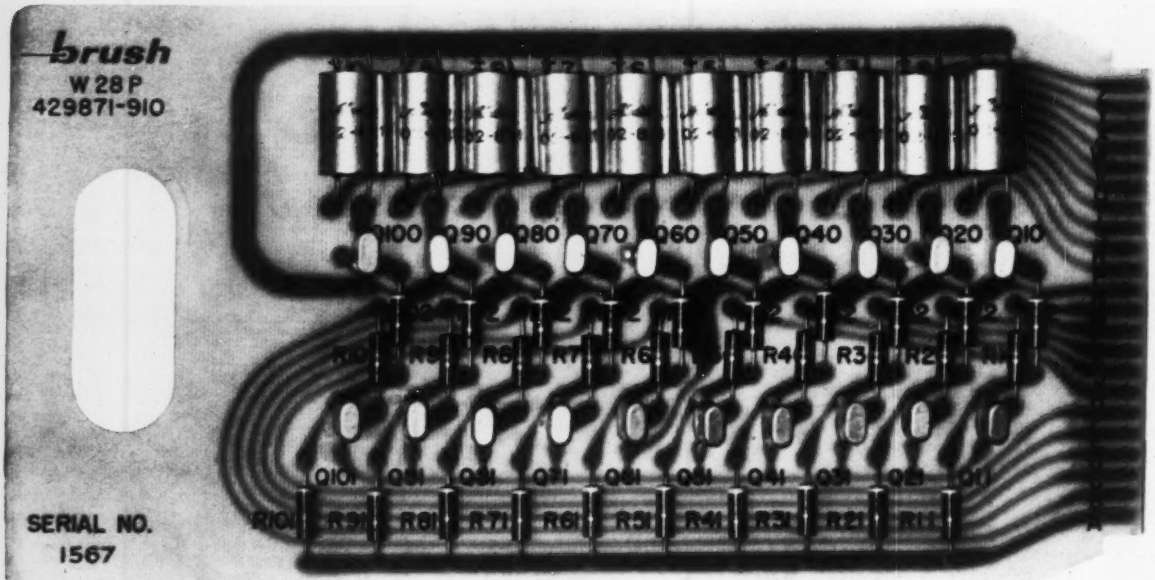
brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO



→

compact transistor switching for millisecond monitoring



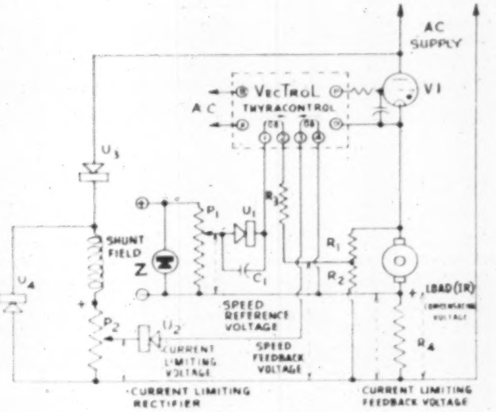

brush
W 28 P
429871-910
SERIAL NO.
1567
Q100
Q90
Q80
Q70
Q60
Q50
Q40
Q30
Q20
Q10
R40
R30
R20
Q101
Q91
Q81
Q71
Q61
Q51
Q41
Q31
Q21
Q11
R101
R91
R81
R71
R61
R51
R41
R31
R21
R11

The new Brush Trans-Switcher eliminates relays—greatly simplifies your problems of operations monitoring. Designed to take full advantage of the fast response and high resolution of Brush Operations Monitors, this compact, solid-state switching unit accepts up to 100 different "on-off" signals in a broad range of pulse shapes and amplitudes. Interchangeable, plug-in decade boards are designed to accept different voltage ranges and modes of operation. Avoid the "black box" approach—specify the *standard* Brush Trans-Switcher for the ultimate in precise, reliable monitoring. Write for complete details.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

Adjustable Electronic Speed Control

A speed reference voltage is maintained constant by Zener diode Z and adjusted by potentiometer P_1 at the operator's control station. This energizes the VecTrol control terminals 1-2 in opposition to a speed feedback voltage obtained from the armature through potential

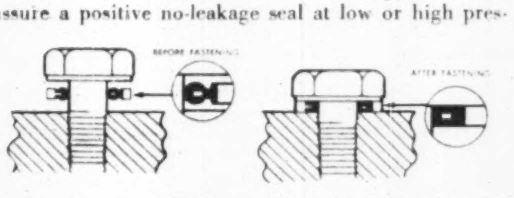

AC SUPPLY
VecTroL
THYRACONTROL
A C
V1
U_3
P_1
U_1
R_3
R_1
R_2
C_1
SHUNT FIELD
Z
U_4
P_2
U_2
LOAD (IR) COMPENSATING VOLTAGE
R_4
SPEED REFERENCE VOLTAGE
SPEED FEEDBACK VOLTAGE
CURRENT LIMITING VOLTAGE
CURRENT LIMITING RECTIFIER
CURRENT LIMITING FEEDBACK VOLTAGE

divider R_1 and R_2. This feedback circuit automatically regulates the armature voltage to a constant value, such as that required to maintain the feedback voltage across R_2 . . . Additionally, a load compensating voltage which is proportional to the resistive loss or IR drop in the armature is developed across resistor R_4 and is added to the speed reference voltage. This increases the armature voltage in direct proportion to the armature current and produces constant armature speed with varying load torque . . . (*From new 4-page Bulletin V-1, ECI Mfg. Div. of Electronics Controls Inc., 85 Magee Ave., Stamford, Conn.*)

FOR THIS LITERATURE CIRCLE 187 ON READER-SERVICE CARD

Metal-retained Seals

Stat-O-Seals offer many superior features for sealing fasteners. The seal is under controlled confinement with full metal-to-metal contact of facing surfaces to assure a positive no-leakage seal at low or high pres-

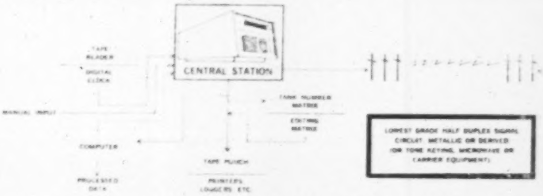

BEFORE FASTENING
AFTER FASTENING

sures or vacuum. High torques and re-torquing are not necessary. Due to unique mechanical fastening of the rubber to the retainer (no chemical bonding) they provide a high re-usability factor, give longer service, and will not "twist" or otherwise foul-up while installing. The single, one-piece configuration provides for fool-proof assembly, and quick, visual installation inspection. They will seal standard bolts, studs and rivets . . . (*From new 8-page Catalog 5422, Parker Seal Co., Culver City, Calif.*)

FOR THIS LITERATURE CIRCLE 188 ON READER-SERVICE CARD

Remote Automatic Telemetering Equipment

The great speed inherent in solid state circuitry permits three basic functions—data gathering, alarm scanning and control—to be effectively accomplished over a single economical low grade half-duplex signal channel . . .

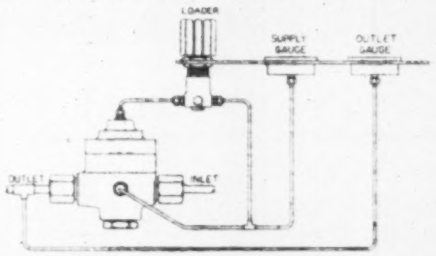

TAPE READER
DIGITAL CLOCK
CENTRAL STATION
MANUAL INPUT
TANK NUMBER MATRIX
EDITING MATRIX
COMPUTER
TAPE PUNCH
PROCESSED DATA
PRINTERS LOGGERS ETC
LOWEST GRADE HALF DUPLEX SIGNAL CIRCUIT METALLIC OR DERIVED (OR TONE KEYING, MICROWAVE OR CARRIER EQUIPMENT)

Pertinent specifications (include:) Capacity—up to 1200 points data, control and alarm. Data Readout—in-line digital display, all categories completely identified; up to 5 significant figures. Readout Time—less than 3 seconds per point over signal grade communications link. Datalogging output: punched tape; any 5-bit (channel) code. Alarm Annunciator: 3-condition, individually identified annunciators for each point . . . (*From new 6-page bulletin, Shand and Jurs Co., 2600 Eighth St., Berkeley 10, Calif.*)

FOR THIS LITERATURE CIRCLE 189 ON READER-SERVICE CARD

Compensated Regulators

GD90A and GD100A Series dome-loaded high pressure and high-volume compensated regulators maintain outlet pressure constant as the inlet pressure decays. This type of single-stage regulator has even better characteristics than two stages of regulation because the drop across the regulator is less . . .


LOADER
SUPPLY GAUGE
OUTLET GAUGE
OUTLET
INLET

The dome loading pressure of these regulators is controlled by a "load" and "bleed" valve. To increase the delivery pressure, the "load" valve is opened until the desired outlet pressure is reached. To decrease the outlet pressure the "bleed" valve is opened until desired reduced pressure is reached. Bleeding only vents the dome loading pressure and not the downstream system. Outlet pressure must be vented through a separate valve . . . (*From new 16-page Form R20, Victor Equipment Co., 844 Folsom St., San Francisco 7, Calif.*)

FOR THIS LITERATURE CIRCLE 190 ON READER-SERVICE CARD

←—— CIRCLE 31 ON READER-SERVICE CARD

YOUR POTENTIOMETRIC INSTRUMENTS

HAVE
A HEART
TOO!

NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

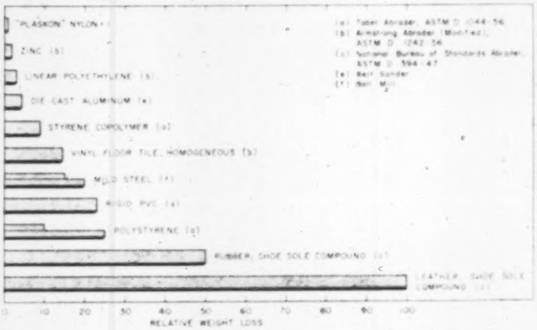
The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

CIRCLE 32 ON READER-SERVICE CARD

Nylon Tubing for Instrument-Air Service

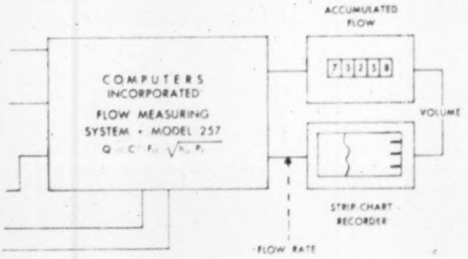
Plaskon Nylon has a hard, abrasion resistant, and lubricous surface. This special property is characteristic of nylon and has led to its use in many load-bearing, anti-friction applications such as gears and bearings. It provides Plaskon Nylon tubing with a great measure of scuff, nick, and gouge resistance. Fig. compares the abrasion resistance of Plaskon Nylon with that of a variety of other materials . . . (*From new 16-page catalog, Allied Chemical, Plastics and Coal Chemicals Div., 40 Rector St., New York 6, N. Y.*)



FOR THIS LITERATURE CIRCLE 191 ON READER-SERVICE CARD

Flow Measuring System

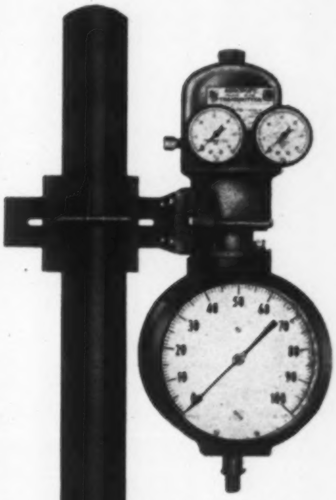
Flow Measuring System Model 257 performs two primary functions: (1) measures the flow rate and accumulated volume of fluid passing through an orifice plate under conditions ranging from steady to intermittent flow, (2) provides signals proportional to these quantities for operation of automatic flow control equipment, and remote control recording equipment. Transducers measure static and differential pressures, and flowing temperatures, and send electrical signals to the computer. The computer then combines these signals . . . (*From new 4-page bulletin, Computers, Inc., 3407 South Shepherd Dr., Houston 6, Tex.*)



FOR THIS LITERATURE CIRCLE 192 ON READER-SERVICE CARD

signal

ASHCROFT PNEUMATIC TRANSMITTERS give you a true primary and transmitted signal for indication or control



Ashcroft Indicating Pneumatic Transmitter

action

Now–detect with precision accuracy the slightest change in primary pressure or temperature. Transmit this signal quickly to your indicators or controllers. Ashcroft Pneumatic Transmitters achieve these results for you at the lowest initial and operating costs.

Full-range, solid-front indicating and totally accessible nonindicating transmitters eliminate the need for costly high pressure lines, yet permit complete monitoring of process conditions in remote areas.

Narrow-span Ashcroft Transmitters are expressly designed with highest sensitivity and repeatability for the most accurate primary signal feed to controllers. You get better control and purer, lower-cost final products.

Only in Ashcroft Pneumatic Transmitters can you get the wide choice of Ashcroft Duragauge Bourdon tubes or American mercury or gas-actuated systems for sensing pressure or temperature conditions. You also get a time-proven, obstruction-proof, force-balance, nonbleed relay for economical, maintenance-free 3-15 psi or 3-27 psi signal transmission.

Write for factful Bulletins 360 and 361 or ask your nearby Ashcroft Distributor to help you select the right transmitters and receiver gauges for your specific requirements.

ASHCROFT PNEUMATIC TRANSMITTERS

A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

CIRCLE 23 ON READER-SERVICE CARD

Large production gives you low prices!
– that's why . . .

Over 100 O.E.Ms have standardized on

AMPERITE

Thermostatic DELAY RELAYS

2 to 180 Seconds

AMPERITE DELAY RELAY

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current. **Hermetically sealed.** Not affected by altitude, moisture, or climate changes. **SPST only**—normally open or closed. Compensated for ambient temperature changes from —55° to + 80° C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.**

Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.

BATTERY VOLTAGE
30
20
10
VOLTAGE OF 24V BATTERY & CHARGER VARIES APPROX.
50%
WITH AMPERITE VOLTAGE VARIES ONLY
2%

AMPERITE REGULATOR

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to + 70° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

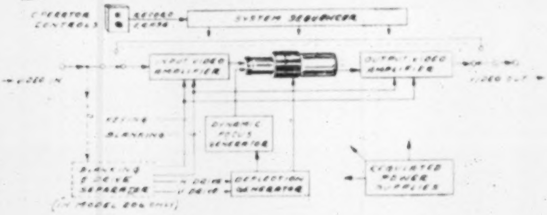
AMPERITE

561 Broadway, New York 12, N. Y. . . . CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

FOR TR-81 CIRCLE 34 ON READER-SERVICE CARD
FOR AB-51 CIRCLE 35 ON READER-SERVICE CARD

TV Picture Storage

The Image Instruments Electrostore makes it possible to instantly store and immediately recall a television picture. The Electrostore records the signal in an electrostatic storage tube; it uses no film, tape, or other expendable material and does not require developing or other processing . . .



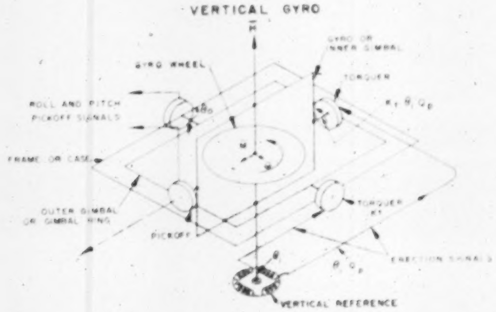
OPERATOR CONTROLS
RECORD ERASE
SYSTEM SEQUENCER
INPUT VIDEO AMPLIFIER
OUTPUT VIDEO AMPLIFIER
VIDEO IN
VIDEO OUT
KEYING
BLANKING
DYNAMIC FOCUS GENERATOR
BLANKING & DRIVE SEPARATOR
H DRIVE
V DRIVE
DEFLECTION GENERATOR
REGULATED POWER SUPPLIES

Upon closure of a "Store" switch, the Electrostore records the next complete frame and then immediately changes to "read-out" delivering a video signal of the stored picture. When the stored picture is no longer needed, a touch of the "Erase" button erases the old picture and prepares the unit to accept a new picture . . . (*From new 4-page Bulletin* 206,7; *Image Instruments Inc.*, 2300 *Washington St., Newton Lower Falls* 62, *Mass.*)

FOR THIS LITERATURE CIRCLE 193 ON READER-SERVICE CARD

Gyros

The gyroscope is basically a mechanical device, the essential element of which is a flywheel rotating at high angular velocity about an axis. The flywheel is mounted within gimbals which allow it one or two degrees of freedom. Gyroscopes derive their basic applications from two inherent properties, namely precession and gyroscopic inertia . . .



VERTICAL GYRO
GYRO WHEEL
GYRO OR INNER GIMBAL
TORQUER
ROLL AND PITCH PICKOFF SIGNALS
FRAME OR CASE
OUTER GIMBAL OR GIMBAL RING
PICKOFF
TORQUER
ERECTION SIGNALS
VERTICAL REFERENCE

A vertical gyro is a two-degree-of-freedom instrument whose gimbal displacements about each output axis constitute a measure of angular deviation from the local vertical axis . . . The term vertical gyro derives from the fact that it is used to measure displacement from the vertical reference . . . A vertical gyro has 360 degrees of angular motion about the outer gimbal axis and ±85 degrees of angular motion about the inner gimbal axis . . . (*From new 44-page bulletin, Kearfott Div., General Precision, Inc., Little Falls, N. J.*)

FOR THIS LITERATURE CIRCLE 194 ON READER-SERVICE CARD

IT'S WHAT'S INSIDE THAT COUNTS!

And a look inside **General Electric's potentiometric recorder** reveals how you get continuous, more reliable recordings of your process variables. Compare these important features:

1. SILICON DIODE REFERENCE VOLTAGE SOURCE

featuring plug-in design, provides continuous standardization - - - and no dry cells or standard cells are required.

2. *Multi-point Selector Switch*

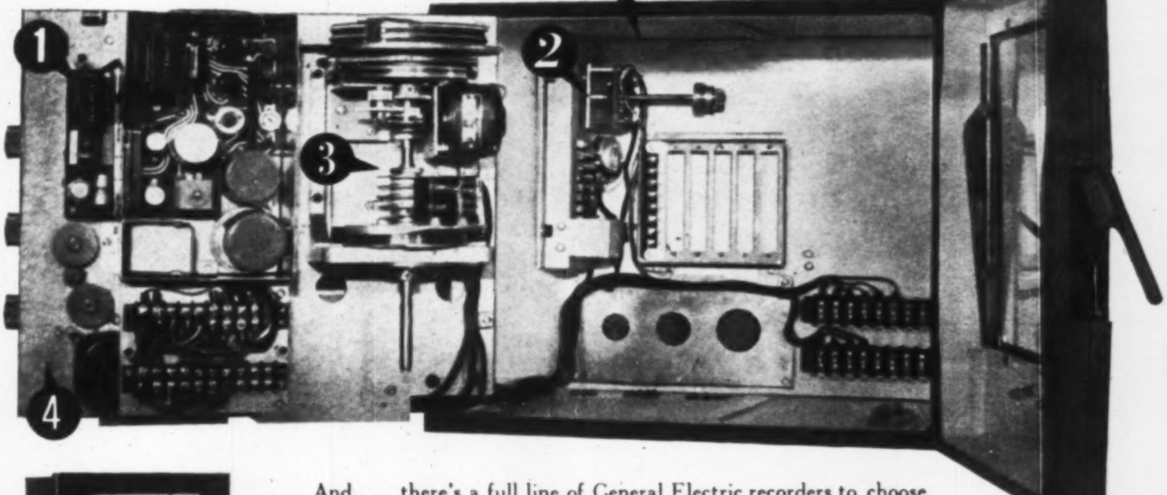
permits remote location - - eliminates long runs and multiple leads.

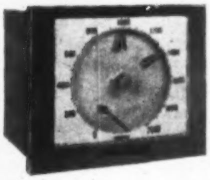
3. CONTROL SWITCHES AND SLIDEWIRES

easily accommodated - - up to 8 control or alarm switches - - up to 4 transmitting slidewires. As many as 4 switches may be adjusted by front-set index - - all switch positions independently adjustable.

4. COMPONENTS MOUNTED ON SWING-OUT PANEL

for easy accessibility include: plug-in amplifier, reference voltage unit, chart-drive motor and other measurement components.





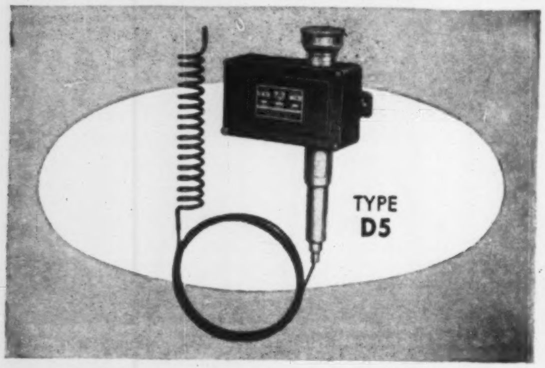
And . . . there's a full line of General Electric recorders to choose from . . . including single-pen, two-pen and multi-point **strip-chart recorders;** plus single-pen and two-pen **round-chart recorders.** Get the complete story on any of these recorders by contacting your nearest G-E Apparatus Sales Office today; or write for bulletins GEA-6887 and GEZ-2969, Section 599-04, General Electric Co., Schenectady 5, N. Y. In Canada, contact Canadian General Electric Co., Limited, 940 Lansdowne Avenue, Toronto 4, Ontario.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 36 ON READER-SERVICE CARD

REMOTE BULB TEMPERATURE CONTROL



UNITED ELECTRIC's Type D5 Remote Bulb Temperature Control is a precision unit containing a micrometer adjustment for obtaining wide ranges and accurate temperature settings. This control has found extensive use in applications such as laboratory and industrial ovens, water baths, hot plates, etc.

Temperature Ranges	−150°F. to +200°F., 70°F. to 370°F., 100°F. to 650°F.
Switch Ratings	15 amps at 115 or 230 volts AC. Also 20 amps or DC switches on specification.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
On-Off Differential	Approximately 1.0°F. or 2.0°F. dependent on model.
Adjustment	Three-turn, calibrated knob rotated against graduated barrel. Readings and divisions equally spaced over entire range. Adjustment knob includes calibration screw.
Electrical Connections	Made to internally located terminal block via clearance hole in the enclosure.
Capillary Tube Length	Standard length six feet. Other lengths available.
Enclosure	Die-cast aluminum case with black wrinkle finish. Other finishes available.
Mounting	Control head surface mounted in any position by means of dog ears. May also be flush mounted.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. Additional data on the Type D5 and other standard remote bulb temperature controls are contained in* Section 200 *of our* new *catalog. Write for your copy now.*

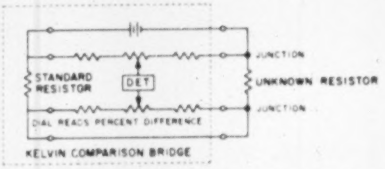
U.E. ®
United Electric Controls
COMPANY
39 SCHOOL STREET, WATERTOWN, MASS

CIRCLE 37 ON READER-SERVICE CARD

ICS BRIEFS

Voltage Divider Calibration

To make precision linearity measurements of a voltage divider, we first calibrate a standard divider to find its deviation, then use this standard to adjust


JUNCTION
STANDARD RESISTOR
DET
UNKNOWN RESISTOR
JUNCTION
DIAL READS PERCENT DIFFERENCE
KELVIN COMPARISON BRIDGE

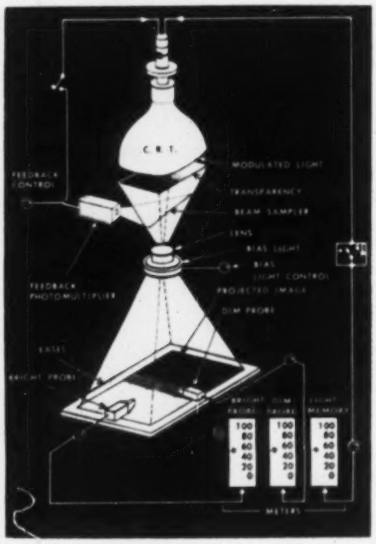
a transfer divider to less than 0.2 ppm deviation, and finally, compare the transfer divider to each decade of the production model . . . (*From new 4-page publication, Design Ideas, Vol. 1/No. 1, Electro Scientific Industries, 7524 S. W. Macadam Ave., Portland 19, Ore.*)

FOR THIS LITERATURE CIRCLE 195 ON READER-SERVICE CARD

Photodrawings

A photodrawing is a combination of photograph and drafting . . .

The heart of Log-Etronics, called the LogEtron, is a cathode ray tube light source. A moving spot of light on the face of the tube is continuously and automatically varied in brightness as it makes the exposure, by feedback from a photomultiplier tube below the negative. Two sensitive light probes at the easel permit the user to measure and control his image brightness range and contrast to match precisely the emulsion on which he is printing, both halftone screen and continuous tone. The varying brightness of the light source automatically exposes each portion of the picture to bring out full shadow, midtone, and highlight detail . . . (*From new 4-page bulletin, LogEtronics, Inc., 500 East Monroe Ave., Alexandria, Va.*)


C.R.T.
MODULATED LIGHT
FEEDBACK CONTROL
TRANSPARENCY
BEAM SAMPLER
LENS
BIAS LIGHT
BIAS LIGHT CONTROL
FEEDBACK PHOTOMULTIPLIER
PROJECTED IMAGE
DIM PROBE
EASEL
BRIGHT PROBE
BRIGHT PROBE
DIM PROBE
LIGHT MEMORY
100
80
60
40
20
0
METERS

FOR THIS LITERATURE CIRCLE 196 ON READER-SERVICE CARD

DU PONT ANNOUNCES
LINO-WRIT 5
DIRECT WRITING PHOTORECORDING PAPER

. . . developed as a completely dry process paper offering these advantages:

HIGH WRITING SPEED—up to 40,000 inches per second

HIGH CONTRAST—yields easy-to-read traces

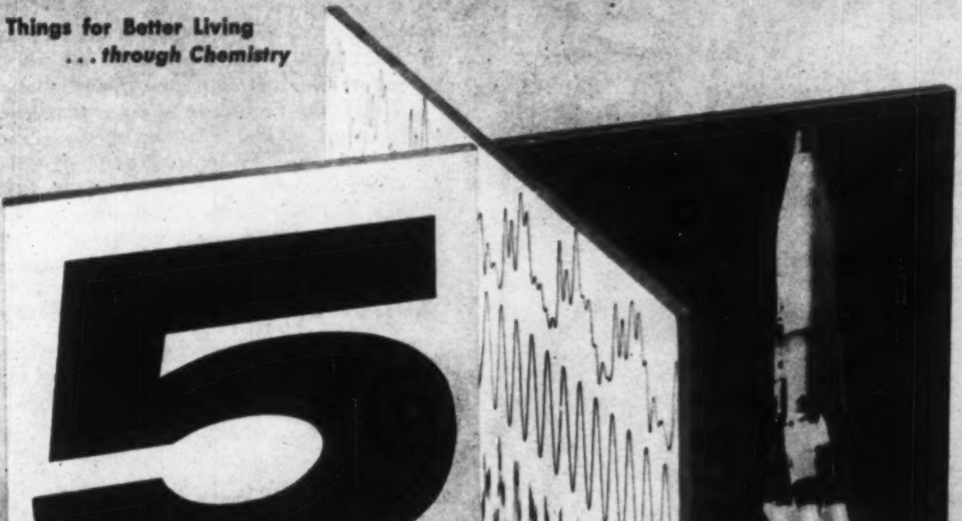
STABLE IMAGE—lasts indefinitely with proper handling . . .
without stabilizing solutions

Your Du Pont Technical Representative can furnish you technical information on Lino-Writ 5 and your Lino-Writ dealer will offer you prompt delivery —the same prompt service you have been used to receiving with the rest of Du Pont's complete line of photorecording papers.

For a new brochure about Lino-Writ 5, write E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, N-2430-A, Wilmington 98, Delaware.

DU PONT

Better Things for Better Living
. . . through Chemistry



CIRCLE 38 ON READER-SERVICE CARD

Harvey-WELLS
ELECTRONICS

NEW ECONOMICAL

SHAFT-ENCODER-TRANSLATOR

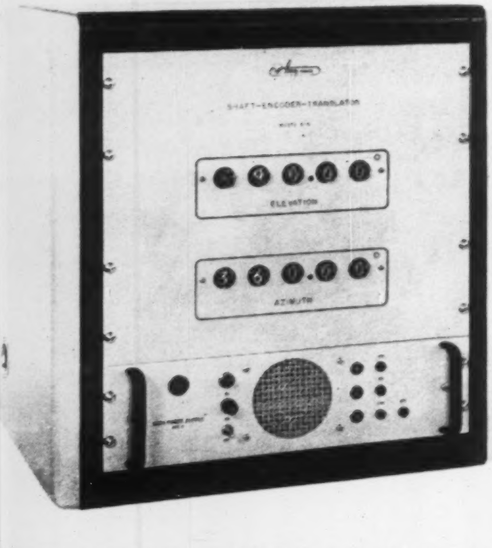
Will convert most photo-electric shaft-encoders producing Gray Code to:

1. Straight Binary
2. Binary-Coded Decimal
3. Binary-Coded Decimal displayed in degrees, radians or any fraction of the circle.

Features

1. Economical! Low cost due to use of Standard H-W Data-Pac® Units
2. Visual display with "nixie" indicator lights
3. Outputs for printout applications in Binary-Coded Decimal available
4. Can be time shared for any number of shaft-encoders using additional display units.
5. Delivery 60 days or less

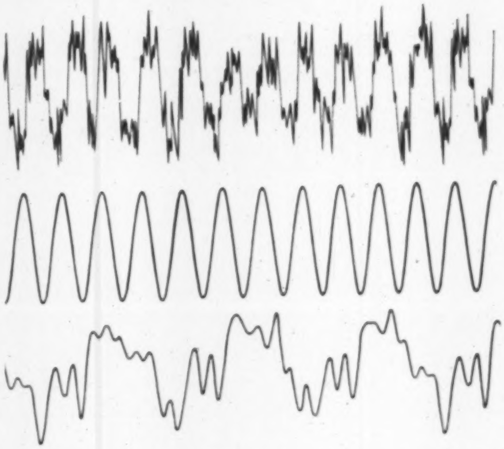
HARVEY-WELLS ELECTRONICS, INC.
14 Huron Drive • Natick, Mass.
CEdar 5-7370 • OLympic 3-7380



CIRCLE 39 ON READER-SERVICE CARD

Direct-writing Photorecording Paper

Designed for use in direct writing oscillographs, Lino-Writ 5 is available in two weights: Type B, standard weight; and Type W, ultra-thin . . .

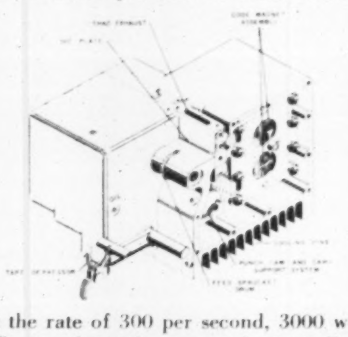


Exposure is made in oscillographs equipped with high intensity light sources (high pressure mercury lights, fluorescent ultraviolet lights, flash tubes and strobotrons) . . . *Development* or *Intensification* takes place in ordinary room light. Fluorescent lighting is especially effective. The image will appear in 15 to 30 seconds when illuminated with approximately 30 foot-candles of fluorescent light and will continue to increase in density for approximately half an hour . . . *Production Processing* of large quantities can be accomplished by the following method. The image may be developed by applying heat followed by blue or ultraviolet light exposure . . . (*From new 4-page bulletin, E. I. duPont de Nemours & Co., Inc., Photo Products Dept., Wilmington 98, Del.*)

FOR THIS LITERATURE CIRCLE 197 ON READER-SERVICE CARD

Super-Speed Tape Perforator

The Model GP-2 Super-Speed Tape Perforator . . . records digital data in standard perforated tape at extreme speeds. Hole patterns or data codes are recorded at the rate of 300 per second, 3000 words per minute. The punch can be accurately controlled to create nearly 10 million precisely located holes per hour . . . (*From new 24-page bulletin, Soroban Engineering, Inc., Box 1717, Melbourne, Fla.*)



FOR THIS LITERATURE CIRCLE 198 ON READER-SERVICE CARD

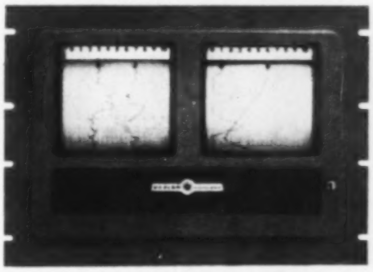
A new addition
to VARIAN'S G-22
Dual Channel
Potentiometer
Recorder

ADJUSTABLE SPAN

0-10 MV TO 0-500 VOLTS

More versatile than ever, the Varian G-22 will now record from sources of almost any likely signal voltage. A newly available plug-in input chassis, the B-22 attenuator type, is easily set as needed from spans as little as 10 millivolts full scale to as high as 500 volts. Front-panel adjustment is continuous in between for optimizing use of the chart's full width in any recording situation.

The G-22 can be your best all-purpose recorder in other ways too. Two channels in themselves also mean versatility—they make the recorder a correlator of simultaneous variables (any two you choose). Two plug-in input chassis mean that each channel's recording characteristics can be quickly changed. And zero can be reset anywhere across the chart from left to right—each channel separately. Last but not least don't underestimate the value of the handle on top. This recorder goes wherever there is recording to be done.*



*Varian offers rack mounted versions too—either singles or twins. The latter is pictured, showing how four channels of recording can be fitted within the 19-inch width of a standard rack.

SPECIFICATIONS, OPTIONS, AND ACCESSORIES

One second full scale balancing time • Accuracy 1% of full scale • Sensitivity 0.25% of full scale • Two chart speeds standard, four speeds optional • Wide selection of chart speeds from ⅛" per hour to 16" per minute • Weight 33 pounds • Available accessories include retransmitting slide wires, alarm contacts, event markers, etc.

For full specifications, write the Instrument Division.

VARIAN associates
PALO ALTO 27, CALIFORNIA

NMR & EPR SPECTROMETERS, MAGNETS, FLUXMETERS, GRAPHIC RECORDERS, MAGNETOMETERS, MICROWAVE TUBES, MICROWAVE SYSTEM COMPONENTS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 40 ON READER-SERVICE CARD

Universal Interferometer
ASKANIA

Askania Testing and Measuring Instruments for Workshop and Laboratory are valuable aids throughout the world

- Precision Angle Measuring Instruments for optics (Spectrometer)
- Precision Spherometers with thickness gauge for lenses, test glasses, mirrors, plates, etc.
- Universal Interferometers
- Testing Instruments for objectives
- Collimators for adjusting optical instruments
- Plane and Plane-parallel Glass Plates
- Interference Comparators for precision gauge blocks

Precision Spherometer

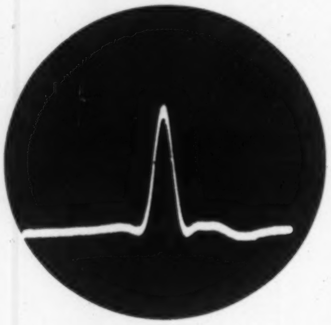
For details
and pamphlets
please write to

ASKANIA-WERKE
U. S. Branch Office
4913 Cordell Avenue
Bethesda 14, Maryland

CIRCLE 41 ON READER-SERVICE CARD

Video-Band Recorder/Reproducer

The Mincom CM-100 is the first magnetic tape system that does the work of two by storing both analog and pulse data with equal facility . . . For example, the CM-100 records and reproduces 1 mc at 120 ips, 12 minutes recording time. It offers equal gradient performance at each of its six speeds, with seven tracks on a single ½-inch Scotch Brand tape . . .

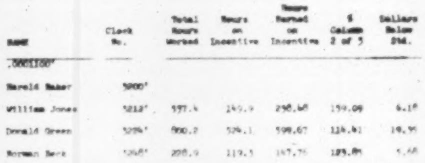


By converting the input AC to DC for use throughout the tape transport, a high degree of flexibility and efficiency is achieved . . . Picture shows 1-microsecond pulse . . . (*From new* 12-*page bulletin, Mincom Div., Minnesota Mining and Mfg. Co.,* 2049 *South Barrington Ave., Los Angeles* 25, *Calif.*)

FOR THIS LITERATURE CIRCLE 199 ON READER-SERVICE CARD

Electronic Computer Helps Break Office Paperwork Jam

Economy Forms Corp., Des Moines, Iowa, manufactures, sells, and rents steel forms for concrete construction. With 350 employees, two different manufacturing plants, and eight district offices and warehouses, a considerable volume of paper was shuffled back and forth . . . The company's management decided to install an integrated electronic data processing system to handle incentive payroll, sales analysis, and finished goods inventory record-keeping . . . Equipment for this system consists of a Royal McBee LGP-30 computer with, as standard equipment, an input-output tape typewriter. Management now has available on its desks daily the complete payroll report. It lists names, clock numbers, accumulative hours worked during the current week, dollars earned above standard on incentive work, dollars below standard (printed in red), and overtime hours . . . (*From new Application Report* 14, *Royal McBee, Data Processing Div., Port Chester, N. Y.*)



FOR THIS LITERATURE CIRCLE 200 ON READER-SERVICE CARD

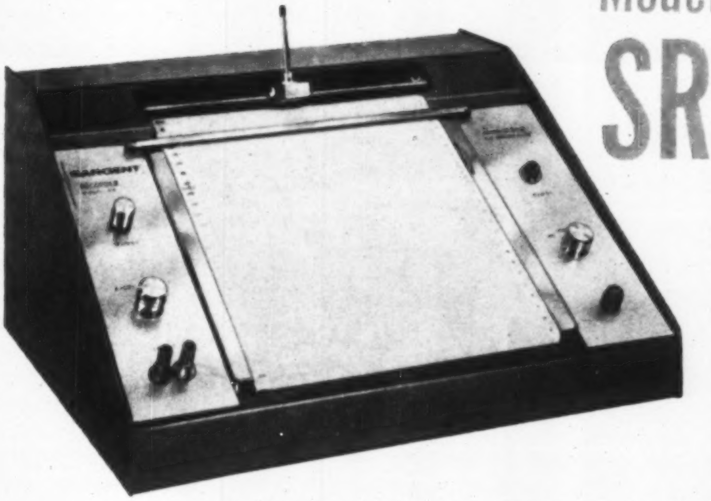
SARGENT

Laboratory Recorders

Designed For Your Specific Laboratory Needs

Model

MR



Model

SR

Designed and Manufactured by E. H. Sargent & Co.

The Model "MR" Recorder

Here is the ultimate in recorders designed exclusively for almost all measurements commonly made in the chemical laboratory. This instrument measures current and voltage and all other quantities which can be transposed into potential or current signals.

The Model "MR" features: 31 Potentiometric Ranges; 9 Chart Speeds, or 27 Chart Speeds with the Sargent Multi-range Attachment; and it is designed for laboratory bench operation.

S-72150 Sargent Recorder
(Pat. No. 2,931,964) $1725.00

S-72151 Sargent Recorder
with Multi-Range Attachment, 27 Chart Speeds $1775.00

For complete specifications write for Bulletin R

The Model "SR" Recorder

Sargent offers the Model SR to fill the need for a low cost recorder that features: maximum accuracy at a minimum cost; 250 mm width chart; fast balancing speed of 1 second; high sensitivity, high gain amplifier; and square cornering at 10,000 to 50,000 ohms input. This instrument provides the minimum required flexibility at the lowest possible cost.

S-72180 Sargent Recorder
(Pat. No. 2,931,964) $675.00

For complete specifications write for Bulletin SR-A

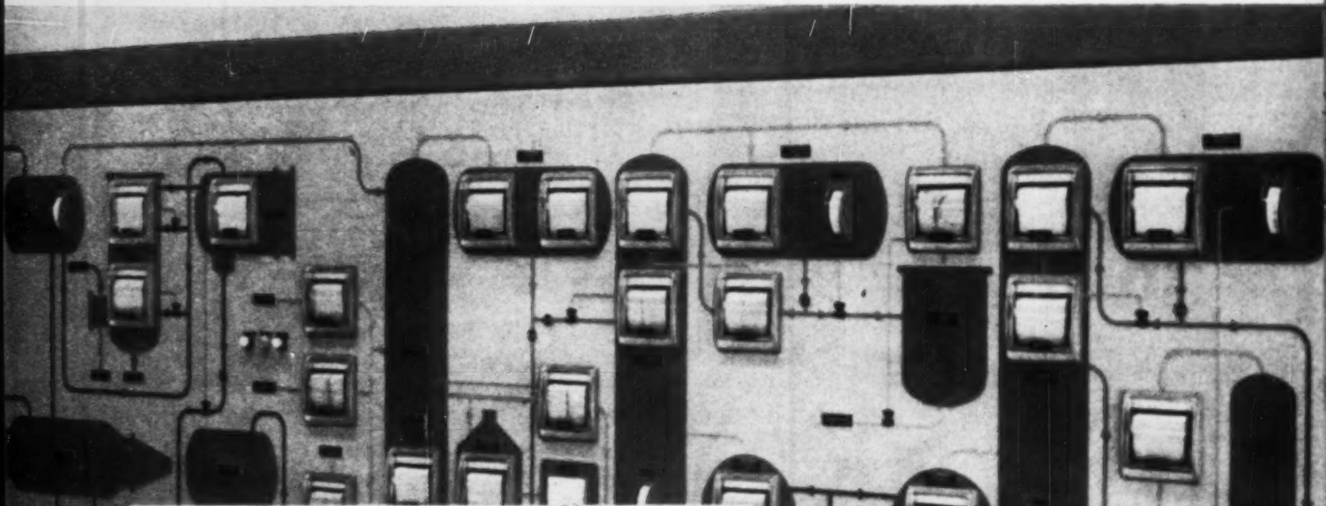
SARGENT SCIENTIFIC LABORATORY INSTRUMENTS • APPARATUS • SUPPLIES • CHEMICALS

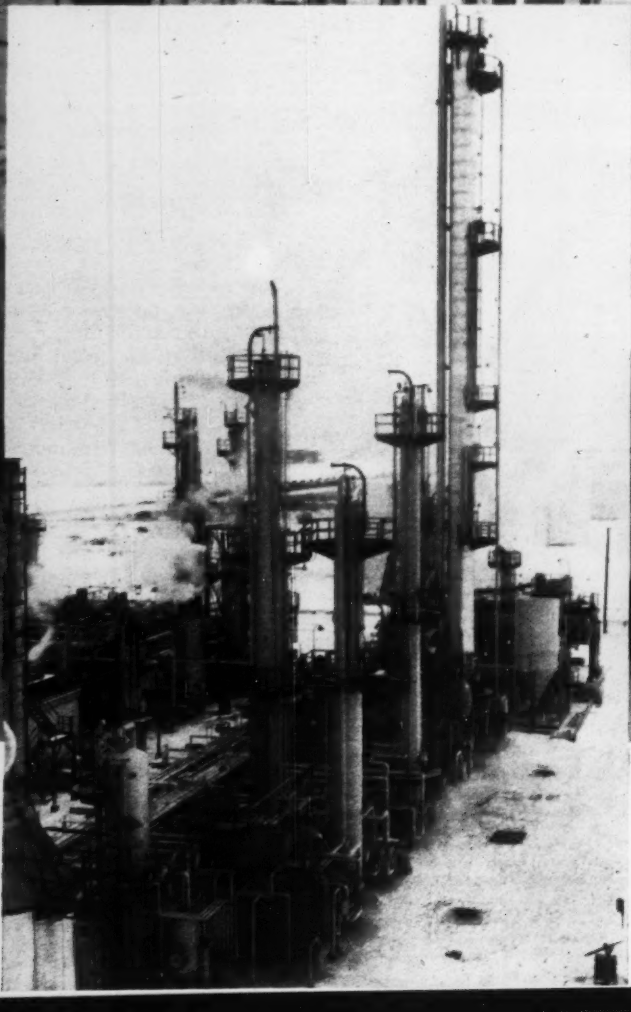
E. H. SARGENT & CO., 4647 W. FOSTER, CHICAGO 30, ILLINOIS
DETROIT 4, MICH. • DALLAS 35, TEXAS • BIRMINGHAM 4, ALA. • SPRINGFIELD, N.J.

CIRCLE 42 ON READER-SERVICE CARD

at Imperial Oil Limited

They wanted a low they chose Foxboro

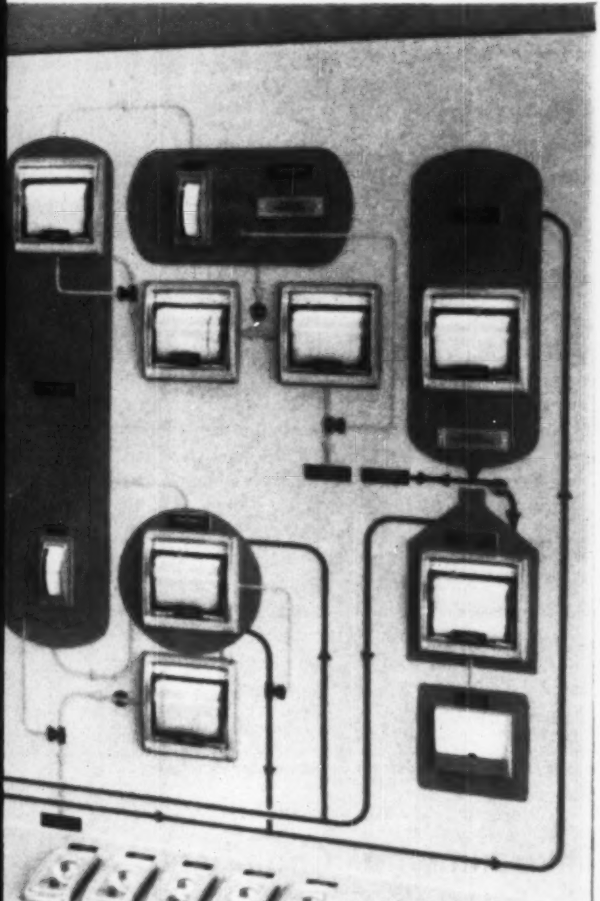




◀ New Hydrofluoric Acid Alkylation Unit at Imperial Oil Limited, Winnipeg, Manitoba. Unit was designed by the Universal Oil Products Company for Imperial Oil.

PHOTOGRAPHY BY FREDERIC ALKIER, WINNIPEG

maintenance electronic system... Electronic Consotrol instrumentation



problems of "frozen" air and vacuum tubes eliminated in new HF Alkylation Unit at Winnipeg, Manitoba

There were significant reasons for installing Foxboro Electronic Consotrol* Instrumentation on Imperial Oil's new HF Alkylation Unit in Winnipeg, Manitoba.

First — Foxboro electronics completely eliminated their problem of air supply — particularly vexing in a climate where the temperature drops below freezing 9 months out of the year.

And second — they like Foxboro's "all solid state" feature, because they'll never have an instrument failure due to a burned out vacuum tube.

Imperial Oil also appreciates the compactness of Foxboro electronic control panels. Compact 3" x 6" controllers are located on sloping panel console — 4-inch strip chart recorders are integrally-mounted in graphic diagram. With a minimum of searching, the operator knows how the process stands.

If speed of response, sensitivity, and reliability play an important role in your process, it will pay you to investigate Foxboro Electronic Consotrol instrumentation. Ask your Foxboro Field Engineer about it. Or write for Bulletin 21-10. The Foxboro Company, 1610 Neponset Avenue, Foxboro, Massachusetts.

Reg. U. S. Pat. Off.

▲ **FOXBORO ELECTRONIC CONSOTROL PANEL** at Imperial Oil includes 32 control loops. 3" x 6" Control Stations are so compact they are mounted on panel console, while recorders are mounted directly in the graphic diagram above.

FOXBORO

REG. U. S. PAT. OFF.

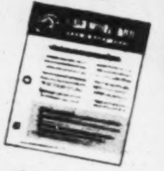
CIRCLE 43 ON READER-SERVICE CARD

Thermocouple Alloy

TRADE NAMES

vs.

ISA* STANDARDS



New data on Thermocouple alloys

Trade names CAN protect you . . . from improvements.

Specify Type K thermocouple wire per ISA Standards . . . and ask your supplier about his experience with the new Thermo-Kanthal alloys.

Their increased stable life means more accurate readings for longer periods . . . with no change in instrumentation required.

If your supplier's tests are not completed, write for Thermo-Kanthal Alloy Bulletin and lower prices.

May we quote on your bare and insulated wire requirements?

KANTHAL

* Instrument Society of America

THE **KANTHAL** CORPORATION

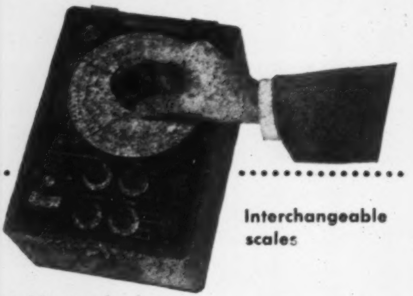
17 Amelia Place, Stamford, Conn.
Canadian Representative
Ferro Enamels, Oakville, Ont.

CIRCLE 44 ON READER-SERVICE CARD

Calibrate Pyrometers

. . . Measure Temperatures

Read temperatures or millivolts directly



Interchangeable scales

A portable standard

The Pyrotest checks recorders, controllers and thermocouples . . . measures temperatures. It is a precision signal source, simulating thermocouple temperatures, for checking other potentiometers. Built-in "run up" permits checking of millivoltmeters.

19 different stock scales will fit one Pyrotest! Scales interchange in seconds. °F. or °C. calibrations for all types of thermocouples supplied. Scales directly read temperatures or millivolts.

Features include cold junction compensation, high accuracy, built-in standard cell. Request Bulletin 9B for complete specifications.

TECHNIQUE

TECHNIQUE ASSOCIATES

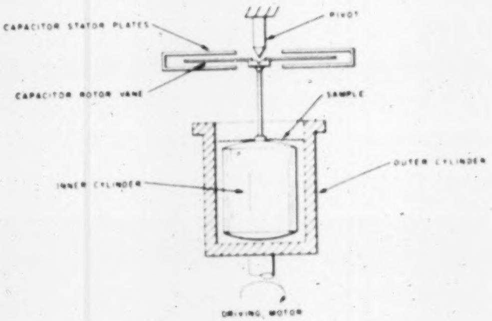
A Division of Duncan Electric Co., Inc.

P. O. BOX 91 • INDIANAPOLIS 6, INDIANA

CIRCLE 45 ON READER-SERVICE CARD

Viscometer for Polymer Research

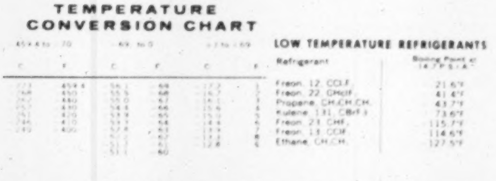
One of the fundamental measurement problems is determination of molecular weight. A convenient index to the molecular weight has been found in the intrinsic viscosity of a polymer under study . . . The basic coaxial cylinders due to Couette were selected for the application of shear stress, with conical ends to minimize end effects. The outer cylinder is rotated at a selected rate, and the viscous torque transmitted to the inner cylinder measured . . . Because a capacitor stores energy in its electrostatic field when a potential is applied, a properly shaped variable capacitor can act as a frictionless spring. By attaching vanes to the shaft of the inner cylinder and allowing them to pass between stator plates, it is possible to generate an electrostatic torque. Then, adjustment of this torque by controlling applied voltage affords the means to strike a torque balance. When electrostatic and viscous torques are equilibrated, the viscous torque can be precisely determined merely by noting the voltage applied . . . (*From new 4-page paper by R. Spiegel, Polarad Electronics Corp., 43020 34th St., Long Island City 1, N. Y.*)



FOR THIS LITERATURE CIRCLE 201 ON READER-SERVICE CARD

Environmental Chambers

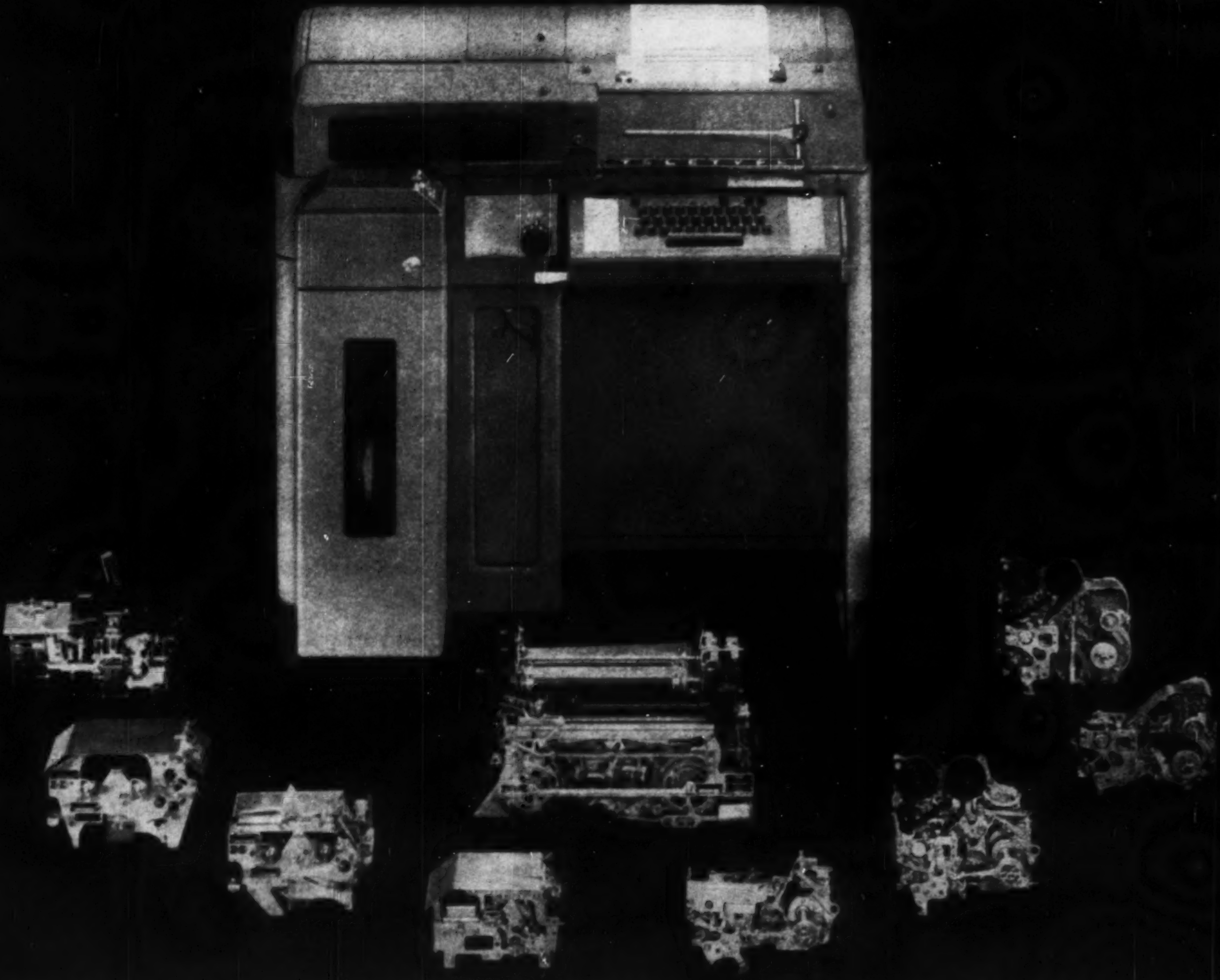
Webber Environmental Chambers make possible the experimentation and testing of materials under extreme temperature and atmospheric conditions. Tensile strength, brittleness, contraction, expansion, magnetic conduction, viscosity, corrosion of thousands of products can be easily determined . . . (*From new 36-page Bulletin 600, Webber Mfg. Co., Inc., Box 217, Indianapolis, Ind., including atmosphere chart, high-altitude chart, and technical information.*)



TEMPERATURE CONVERSION CHART

LOW TEMPERATURE REFRIGERANTS

FOR THIS LITERATURE CIRCLE 202 ON READER-SERVICE CARD



Complete message center in one Teletype machine

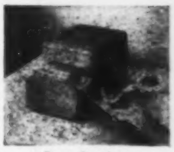
A complete message center in a compact cabinet, with a choice of components to best meet your individual needs—that's the story of the Teletype Model 28 automatic send-receive set.

It provides facilities for sending and receiving on message paper or sprocket-fed business forms. In addition, there is a choice of four different tape reader and four different tape punch components—for preparing punched tape and for sending and receiving with tape.

The flexibility of the set is further broadened by a built-in control unit, the "stunt box," which may be equipped for a wide variety of extra features and switching duties—eliminating the need for external apparatus often required for such functions.

The ASR set is a compact, efficient tool to speed communications and cut costly paperwork. Teletype Corporation manufactures this equipment for the Bell System and others who require the finest in data communications equipment.

Typing Tape Punch



Tape Reader

Send-Receive Page Printer

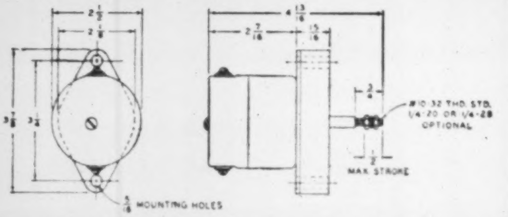
Automatic Send-Receive Set

FREE Model 28 line folder. Write Dept. 27-K,
5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

CIRCLE 46 ON READER-SERVICE CARD

D. C. SOLENOIDS



Synchro-Start SL SERIES SOLENOIDS

are for operating engine throttles, fuel pump racks, chokes, etc. and are available with several variations. Other models in 1″ and 1½″ strokes.

VOLTAGES
(D. C. Only)
6V. 12V. 24V. 32V.

CURRENT DRAW
(Pulling)
55A. 35A. 15A. 12A.

CURRENT DRAW
(Holding)
1.6A. .8A. .4A. .3A.

DUTY
Continuous

CYCLES
Not to exceed 6 per minute

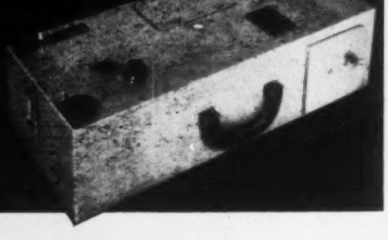
PULL
Approximately 10 lbs. over ½″ stroke

WEIGHT
2¼ pounds

SYNCHRO-START PRODUCTS, INC.
8151 N. RIDGEWAY AVENUE · SKOKIE, ILL.

CIRCLE 47 ON READER-SERVICE CARD

PORTABLE...ACCURATE...EASY TO OPERATE...



Sprengnether's
Blast and
Vibration
Seismograph

PROVIDES EFFECTIVE, SIMPLE METHOD OF ANALYSING AND DETERMINING TRUE VALUE OF VIBRATIONS......

Typical Applications:

- Explosive Testing
- Measuring Vibration Effects to Plant and Equipment from Operating Heavy Machinery.
- Rocket Engine Testing
- Determine Vibration Response of Members During Construction and After Completion of Building.

Portability: (38 lbs.—25 x 10 x 8 in.) Unit is self contained and free from external power source.

Extremely Accurate: To guard against error, each instrument is tested and calibration data furnished. Frequency response, 3 to 200 cycles per second. Timing lines are across record at intervals of 0.02 seconds with accuracy of 0.1%.

Easy To Operate: All controls are easily accessible. Instrument can be set up, leveled and made ready to operate within minutes.

Write today for complete information.

Internationally Known Mfrs. of Seismological, Geophysical Instruments.

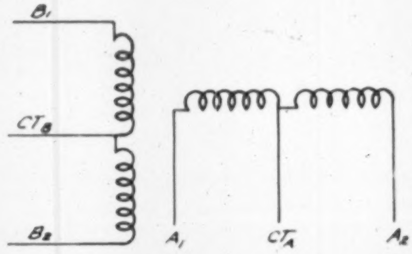
W. F. SPRENGNETHER INSTRUMENT CO., INC.
4567 SWAN AVENUE • ST. LOUIS 10, MO.

CIRCLE 48 ON READER-SERVICE CARD

ICS BRIEFS

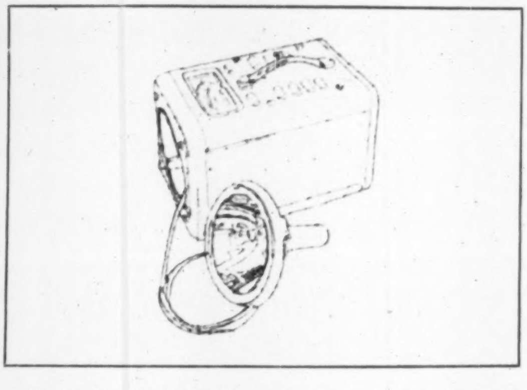
Digital Stepper Motor Tester

In order to test these motors to prove performance, an analyzer capable of providing a wide variety of test conditions and capable of fully evaluating the test results was required . . . This analyzer, developed by Servomechanisms, Inc., automatically checks motor response . . . The analyzer consists of a square wave generator which has provisions for varying the frequency, pulse width, and amplitude of the output waveform, a pickoff assembly which detects the actual mechanical rotation of the stepper motor, and counter circuits to tally and record the stepper motor input and output pulses . . . A built-in logic circuit determines the rotation of the motor . . . The test fixture provides stepping rates up to 1000 pulses per second (500 RPS) and the stepping pulse duty factor can be varied from 10 to 90% . . . (*From new 3-page flyer, Servomechanisms, Mechatrol Div., 1200 Prospect Ave., Westbury, L. I., N. Y.*)



FOR THIS LITERATURE CIRCLE 203 ON READER-SERVICE CARD

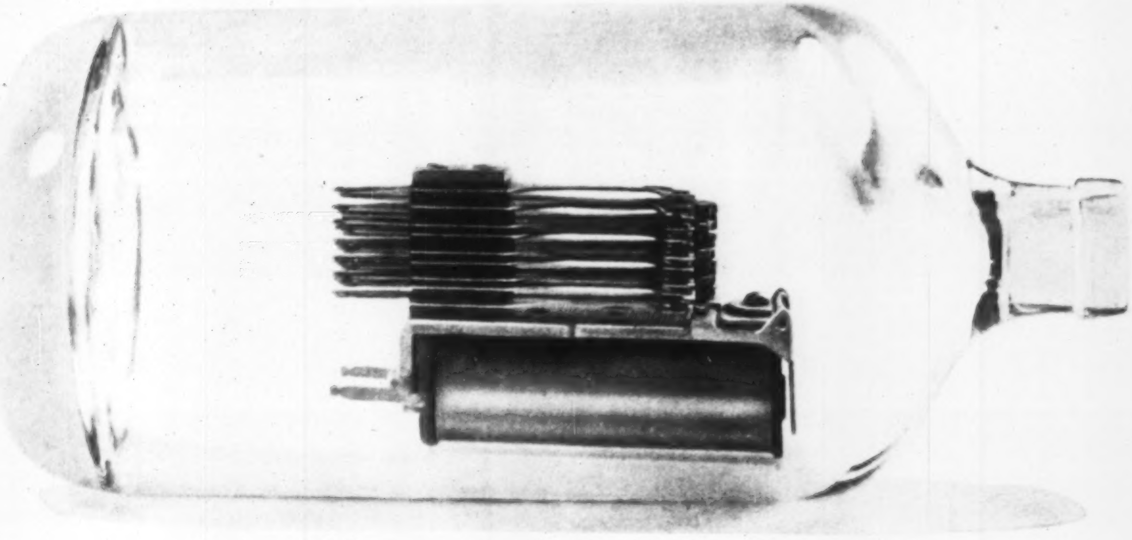
Stroboscope



General purpose instrument covers most needs in industry. Read-out pulse of 5 v peak-peak at output socket facilitates operation of ancillary equipment. Synchronized to lamp flash pulse will operate decade counter where greater accuracy in speed measurement is needed or trigger photographic equipment. (*From new 4-page catalog of Fairbanks Morse & Co., announcing new EMI line of industrial instruments, including ITV, oscilloscopes, contamination monitors, weighers, etc.*)

FOR THIS LITERATURE CIRCLE 204 ON READER-SERVICE CARD

AE



TO THE ENGINEER

facing an impossible situation

If you have a "hopeless problem" in automatic control, chances are that Automatic Electric can help you solve it in less time than it would normally take you.

What with our specialized experience in cooking up highly educated circuits and components for dial exchanges, we've earned a reputation for making ideas *work* automatically.

As an example: the AE Class B premium-quality telephone-type relay (illustrated) provides hundreds of millions of operations with unfailing contact reliability, and seldom needs maintenance. For this reason alone, it is probably the most inexpensive relay you can use where infallibility is essential.

As a support to your design skill, AE relays and stepping switches are custom-made to your precise engineering specifications. They're also available wired and assembled into complete control packages—a job we can handle for you at low unit cost.

For more information, write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Circular 1702-E on *Relays for Industry.*

**AE
CAN
DO**

AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

CIRCLE 49 ON READER-SERVICE CARD

UNITED STATES
E PLURIBUS UNUM
HALF DOLLAR
QUARTER DOLLAR
LIBERTY

NO MORE COSTLY OVERHEATING PROBLEMS WITH NEW LESLIE-EVENTEMP* REGULATORS

This is more than a promise—it's a money-saving fact! This is the temperature regulator that corrects overheating problems—*before* they get to the heater. A compact pilot design insures dependable, even-tempered control for storage-type heating or cooling.

The Leslie-Eventemp is a single-seated, tight-closing temperature regulator. Its patented Leslie-Spiroflex* metal diaphragm provides long valve travel, long service life. This is the exclusively Leslie feature that makes the Eventemp a *no-nonsense* kind of regulator. Once on the line, it *stays* on the line.

With the Eventemp, you can virtually design regulator downtime out of your system. Its rugged, low-cost temperature-sensing element unscrews in just moments for a range change or replacement. No messy gas fills or vapor pressure elements! No factory returns! The simple internal pilot has sensibly sized ports, and there are no close-fitting parts to act up.

For capacity and application data on Leslie-Eventemp Regulators, write for Bulletin or contact your Leslie Engineer—he's listed in the Yellow Pages under 'Valves' or 'Regulators'.

LESLIE **Leslie Co., 704 Grant Avenue, Lyndhurst, New Jersey**

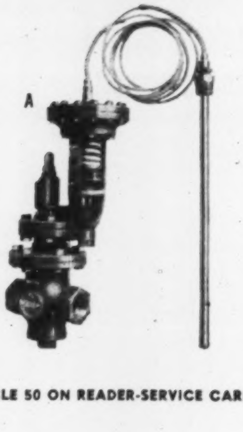
A Leslie-Duomatics* regulate both temperature and pressure in a single regulator. For storage or instantaneous heater services with inlet pressures from 20-600 psig.

B Direct-operated regulators for heating or cooling services in sizes ⅜ to 1". Handle pressure drops up to 100 psi.

C Leslie air-operated temperature pilots operate control valves and air-loaded regulators in heating and cooling services.

*Trade Mark of Leslie Co.

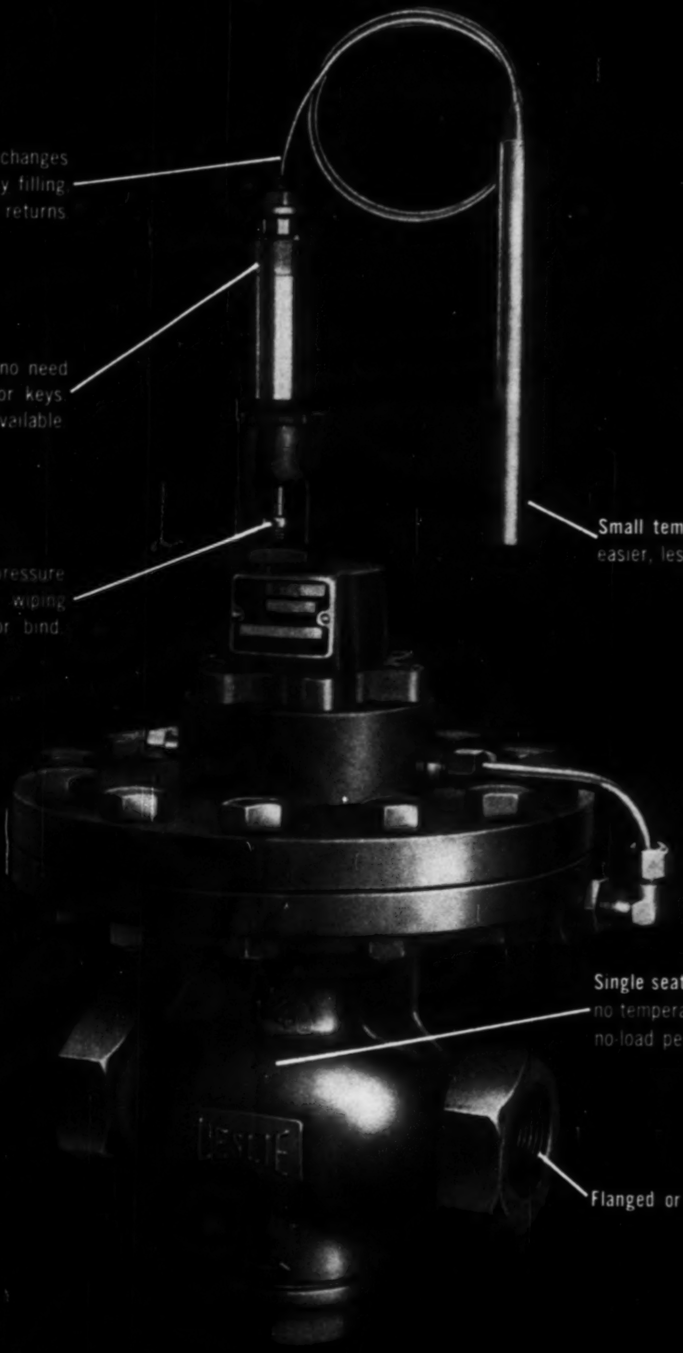
A



B

C

CIRCLE 50 ON READER-SERVICE CARD



Renewable thermo-element — changes in moments. No messy filling, no costly factory returns.

Simple, knurled adjustment — no need for special tools or keys. Calibrated adjustment available.

Friction-free stem seal — pressure sealing with stem wiping action. Can't foul or bind.

Small temperature sensing bulb — easier, less costly to install.

Single seated — tight closing ... no temperature buildup on extended, no-load periods.

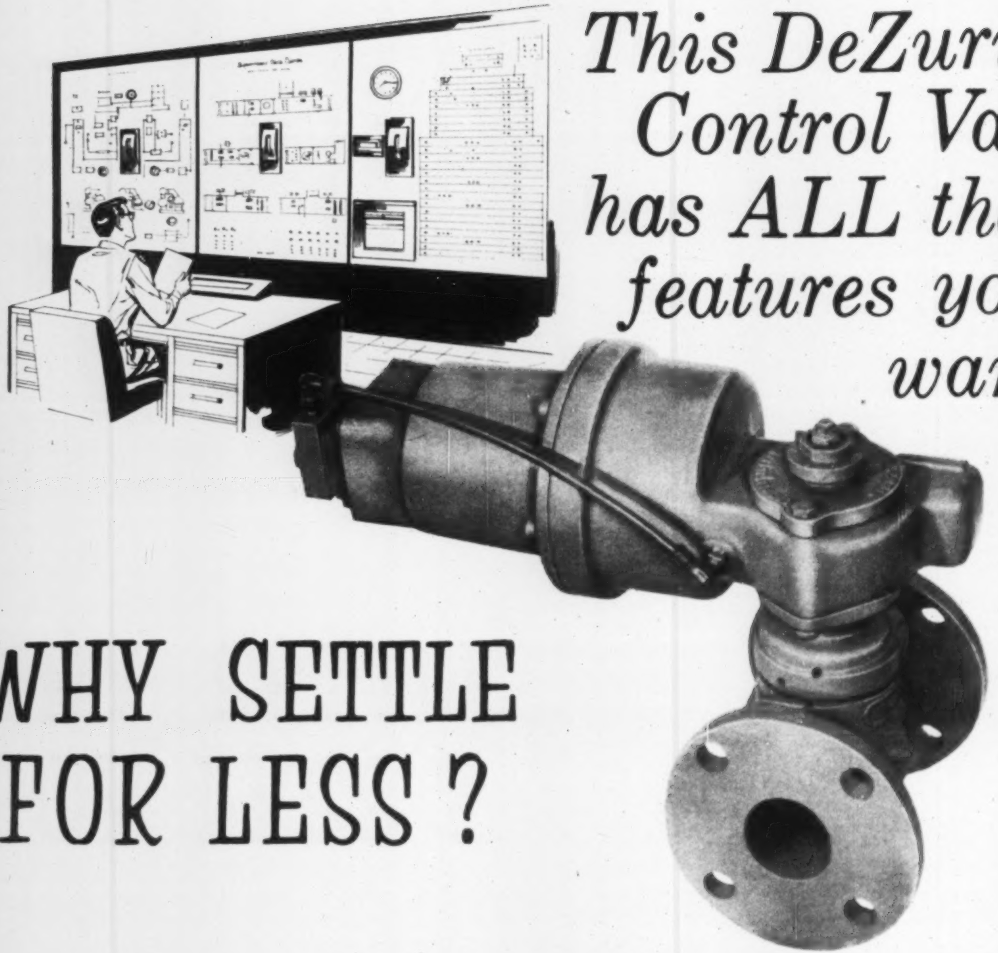
Flanged or screwed end connections.

LESLIE-EVENTEMP Regulators are single seated in all sizes, ¼"–4". In bronze or iron, they handle inlet pressures up to 150 psig.

TRADE
LESLIE
MARK

REGULATORS and CONTROLLERS

This DeZurik Control Valve has ALL the features you want!



WHY SETTLE FOR LESS?

When DeZurik Control Valves, because of their resilient plug facing and eccentric action, shut dead-tight, why settle for even .1% leakage? When straight-thru flow permits higher capacity (a 1″ DeZurik Valve has a flow coefficient of 33, a 3″ valve 330, a 10″ valve 3130!), why take less? When DeZurik eliminates stem leakage with a rotary stem seal kept under constant spring pressure, why accept even minute leakage to atmosphere? When DeZurik Control Valves feature manual operation provision as standard on all models, why pay extra for it?

In short, when DeZurik Control Valves offer you all the precision . . . the versatility . . . the dependability you want and at low cost, why settle for less?

For more details on DeZurik Control Valves see the DeZurik representative in your area, write for Bulletin 150.

DeZURIK
CORPORATION
SARTELL, MINNESOTA

CIRCLE 51 ON READER-SERVICE CARD

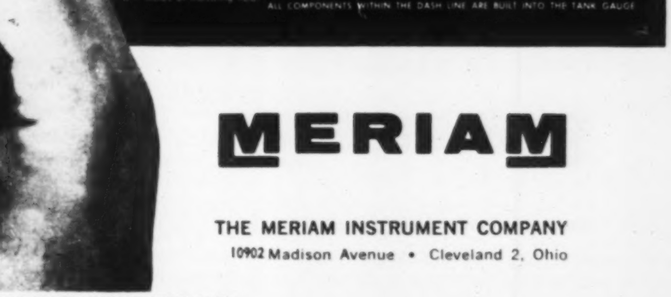
another
MERIAM
FIRST
OPERATING INSTRUCTIONS
TURN ON AIR SUPPLY
TO CHECK SCALE ZERO
1. CLOSE FLOW VALVE
2. OPEN VENT VALVE
3. ADJUST SCALE ZERO ON GAGE COLUMN
4. CLOSE VENT VALVE
SIGHT FLOW IND.
2
1
0
FLOW VALVE
TO READ TANK GAGE
1. PULL PURGE VALVE HOLD OPEN 3 SECONDS
PURGE VALVE
2 SIGHT FLOW IND. BALL SHOULD RISE TO POSITION 2 - RELEASE
VENT VALVE
3. OPEN FLOW VALVE 1/4 TURN OR UNTIL SIGHT FLOW IND. BALL RISES TO POSITION 1
4 READ TANK GAGE

integral blow·down TANK GAUGE

FOR CONTINUOUS PURGING SYSTEMS

Now . . . FOR THE FIRST TIME . . . you can specify a continuous purge tank gauge and blow-down device *with all the working parts in one package!* It's easy to clean out tank gauging lines with this scavenging method that is completely independent of the normal tank gauge operation. Just pull one knob to remove condensate, scale and sludge from your tank gauging lines connected to either vented or pressurized closed tanks. And . . . there's no need for extraneous plumbing! Meriam's new tank gauge requires only two connections to your present system. In hazardous areas, the instrument may be located up to 800 feet from the tank, depending on the filling and emptying cycle. Gauges are available in single or dual blow-down units and in compact multiple-tube groups with up to six gauging tubes in one assembly. Send for complete specifications and operating instructions today.

HERE'S HOW THE MERIAM HYDROSTATIC GAUGING SYSTEM WORKS


CONNECTING LINE
EQUALIZING LINE (where required)
EXTERNAL FILTERED AIR SOURCE
VENT
TANK TOP FITTING
ZERO SET VENT VALVE
TANK GAUGE INDICATING COLUMN
BACKFLOW CHECK VALVE
TRICKLE AIR PURGE VALVE
HI-LO FLOW INDICATOR
H
h
H — inches of tank contents
h — inches of indicating fluid
HIGH-PRESSURE AIR PURGE VALVE
ALL COMPONENTS WITHIN THE DASH LINE ARE BUILT INTO THE TANK GAUGE

Write today for
Bulletin L-10 complete
specifications and
operating instructions.

MERIAM

THE MERIAM INSTRUMENT COMPANY
10902 Madison Avenue • Cleveland 2, Ohio

10006-M I

CIRCLE 52 ON READER-SERVICE CARD

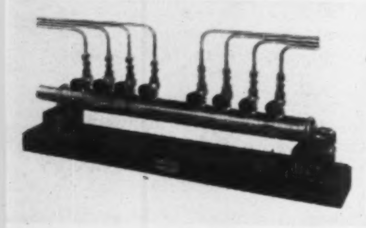
SHELL
VETERANS ADMINISTRATION
Air Products

Judging by the Company We Keep...

Electro-Mech

..."The Company We Keep" insist on perfection in their Control Systems...excellence in workmanship is a hallmark of Control Systems custom manufactured by Electro-Mech.

For one example, consider the Electro-Mech cast bronze air-header, which we use in "supply-air" service on pneumatic control system jobs. This leak-proof, sturdy unit makes a more dependable total installation.



A little thing, you say...it is a little thing, but many small improvements in construction details make the difference between an ACCEPTABLE control panel, and one that's UP TO ELECTRO-MECH STANDARDS.

We invite you to join the "Company We Keep" by requesting an Electro-Mech quotation on YOUR next Control Systems requirement.

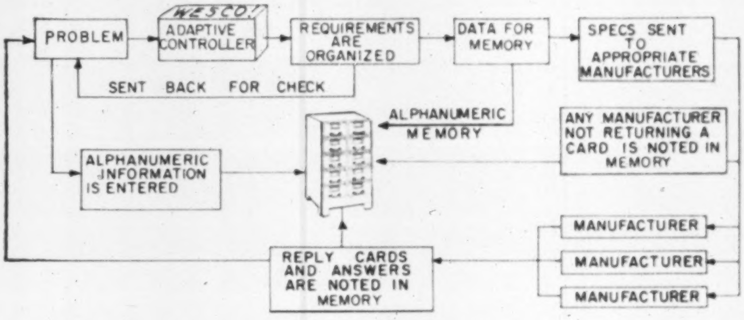
Electro-Mech Corp., Norwood, N. J.

Electro-Mech

CIRCLE 53 ON READER-SERVICE CARD

ICS PANHANDLE PETE

WESCO! Offers New Adaptive Control System for General Use


PROBLEM
WESCO!
ADAPTIVE CONTROLLER
REQUIREMENTS ARE ORGANIZED
DATA FOR MEMORY
SPECS SENT TO APPROPRIATE MANUFACTURERS
SENT BACK FOR CHECK
ALPHANUMERIC MEMORY
ANY MANUFACTURER NOT RETURNING A CARD IS NOTED IN MEMORY
ALPHANUMERIC INFORMATION IS ENTERED
MANUFACTURER
MANUFACTURER
MANUFACTURER
REPLY CARDS AND ANSWERS ARE NOTED IN MEMORY

Adaptive control is the field of tomorrow—and WESCO! offers it today. Everybody knows that the bottle-neck of data is the problem everywhere. WESCO! solves this problem with a new system, the WESCO! 4-L (4-Loop) adaptive servo data and control system.

Design requirements were as follows:

- Must be compatible with all existing codes and techniques.
- Must have low initial cost
- Must have low maintenance costs
- Must have high reliability
- Must receive data from all sources
- Must store and file all data necessary
- Must find all data pertinent to a given problem
- Must printout data
- Must be self-adaptive
- Must do all with minimum of attention and cost

The system has been solved via the WESCO! adaptive controller, shown in Fig. 1. Two examples show the operation:

Example A:

1. Problem arrives via letter or phone from client—for example, client wants thermometer with 0-4500 degree range.
2. Adaptive controller first organizes requirements and closes first loop by checking with input problem to see if all data is received.
3. Coded alphanumeric data then is taken from central file, which lists all possible sources.
4. Letters are sent automatically to all pertinent manufacturers and data is entered in central file.
5. Outer loop is closed by forwarding all replies to subject with problem.
6. Inner loop is closed with redundancy technique by contacting client to see if all manufacturers submitted bids. Negative reply starts entire system into operation until an affirmative (or zero) answer is received from input source.

Example B:

Computing flow data:

1. Problem arrives via memo from boss—for example, company wants total project costs for last week.
2. Adaptive controller closes first loop by checking input to see if all data is received.
3. Required data is taken from file, in which all data is coded alphanumerically.
4. Second loop is closed by entering data into small desk-top computer (adding machine).
5. Redundary technique is used for accuracy (problem is repeated).
6. Outer loop is closed by sending checked result to source initiating the problem.
7. All data are entered in central alphanumeric memory (file) for future use.

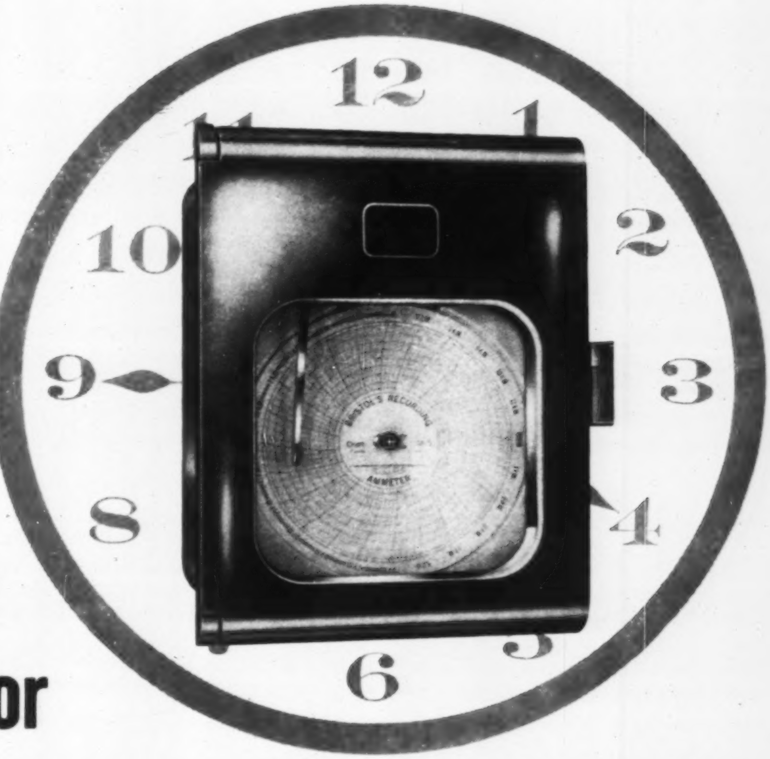
Reliability: system has been checked for several years, and has been found to meet all requirements.

Source and cost of system: WESCO! local secretarial agency. Cost: depends on prevailing wage rate. Alphanumeric memories available with from 1 to 10,000 drawers.

Panhandle Pete

11 big reasons for standardizing on Bristol Recording Ammeters:

1. Negligible temperature influence.
2. High accuracy: ±1% of scale.
3. High torque, keeps weight and power drain to a minimum, assures positive recording over full range.
4. Low electrical burden—only 5 VA at 5 or 10 amps.
5. High calibration stability. Seldom requires calibration.
6. Easy calibration in field. No special tools or skills required.
7. Rugged construction: Shock-proof ball-bearing movements; pen locking device for shipping or carrying.
8. Leveling not critical.
9. Up to 3 pens—for recording up to 3 independent readings.
10. ASA models available; Meet Specifications C39.2-1953.
11. Models for wall, switchboard, flush-panel, pole-mounting, portable and portable pole-mounting use.



The recording ammeter for 'ROUND-THE-CLOCK RELIABILITY

. . . It's a Bristol, of course . . . featuring time-tested moving-iron elements, refined and improved by Bristol R & D

Bristol recording ammeters give you maximum accuracy and reliability under field conditions—all the time.

Big reason is Bristol's ultra-reliable, moving-iron element—the same high-torque, low-burden element that has earned Bristol such a reputation for accuracy and dependability in thousands of installations . . . in electric utility central stations, substations, distribution systems . . . in industrial and process plants.

Bristol recording ammeters, while employing the ultra-reliable, time-tested moving-iron mechanism, incorporate basic improvements and design innovations which make them outstanding for accuracy, ease of calibration, and dependable operation under difficult conditions.

Models with up to three pens, actuated by independent elements, are available as are models for every mounting requirement, chart-drive requirement, or range requirement—all the features are detailed in Bulletin E1111. Write for your copy today. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

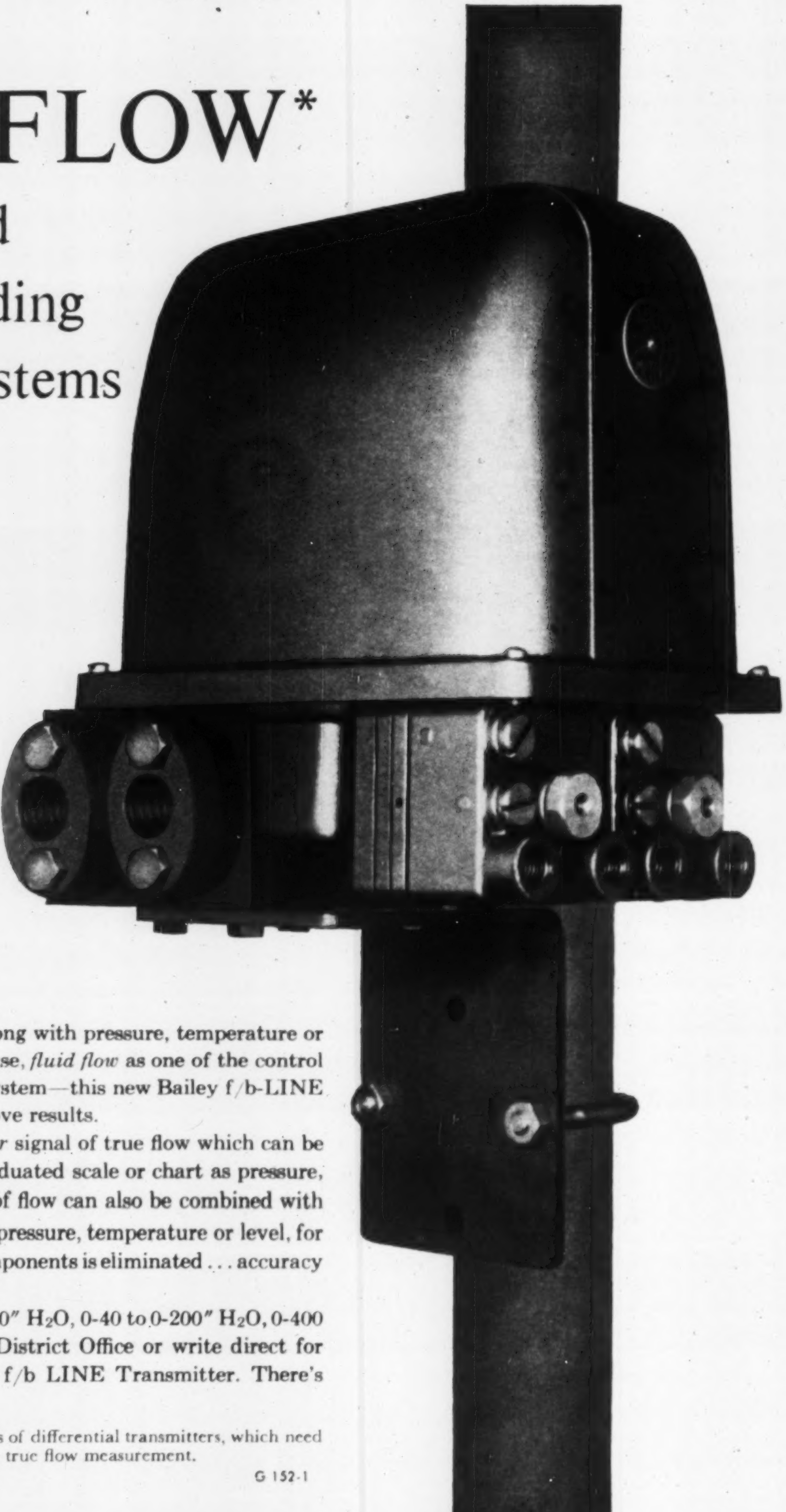
O.4

BRISTOL . . . for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 54 ON READER-SERVICE CARD

Measures TRUE FLOW* to simplify and improve recording and control systems



If you intend to record *fluid flow* along with pressure, temperature or level—or if you now use, or plan to use, *fluid flow* as one of the control factors in a multi-element control system—this new Bailey f/b-LINE Transmitter can simplify and improve results.

It measures and transmits a *linear* signal of true flow which can be recorded on the same uniformly graduated scale or chart as pressure, temperature and level. This signal of flow can also be combined with other linear signals such as those of pressure, temperature or level, for improved control. Need for extra components is eliminated . . . accuracy of flow reading is increased.

Wide selection of ranges: 0-4 to 0-20″ H_2O, 0-40 to 0-200″ H_2O, 0-400 to 0-2000″ H_2O. Call your Bailey District Office or write direct for complete data on the new Bailey f/b LINE Transmitter. There's nothing like it.

*As opposed to pressure-drop measurements of differential transmitters, which need external square root extractors to produce true flow measurement.

G 152-1

BAILEY METERS

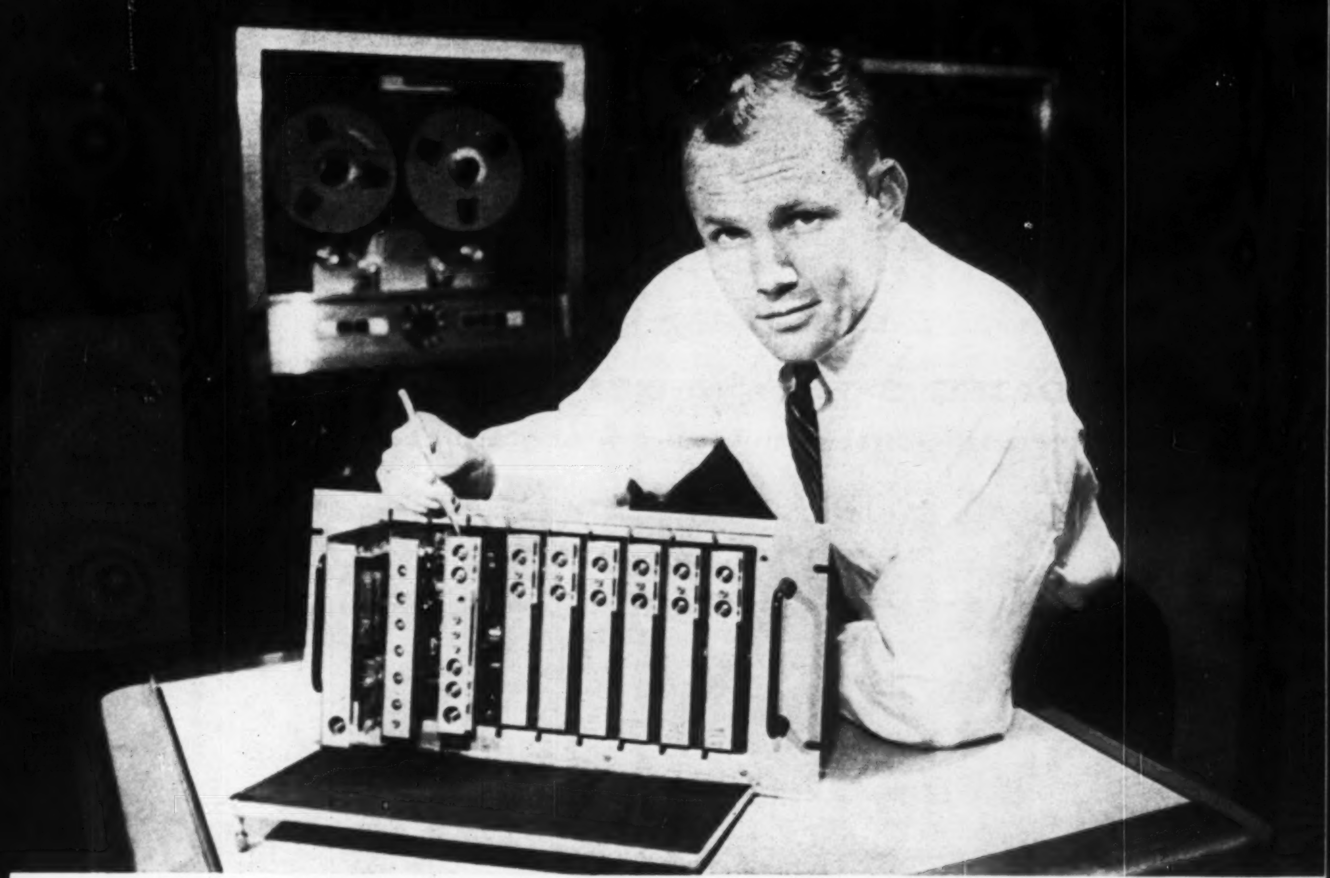
Instruments and controls for power and process

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

CIRCLE 55 ON READER-SERVICE CARD



Raytheon's Revolutionary A-D Converter Handles 5 Million Samples/Second

It is 100 times faster than any other available . . . about the size of an office typewriter . . . offers Industry and the Military a basic, solid state tool compatible with the speeds of newer electronic systems.

It can, with modification, scramble video signals . . . or ride inside a satellite or missile, converting temperature and other environment data.

Its applications encompass almost any product or process requiring continuous, automatic control of a constantly varying multiphase system.

Equipment employing this technique can digitize target information faster, enabling radar control systems to intercept or guide missiles or aircraft more accurately . . . help analyze an oil refining process, or the trajectory of an ICBM, in millionths of a second.

RAYTHEON EQUIPMENT DIVISION

EXCELLENCE IN ELECTRONICS

It is the most recent example of Raytheon Company Communications-Data Processing Capability.

Mail Coupon Today For Folder & Specifications

DIRECTOR OF MARKETING,
Equipment Division,
Department E-1, Raytheon Company,
West Newton, Massachusetts

Please mail me further information on new 7-bit binary code A-D Converter. I am currently concerned with:

____

____

____

____

(type of system)

*Name and Title*________________________

*Company*________________________

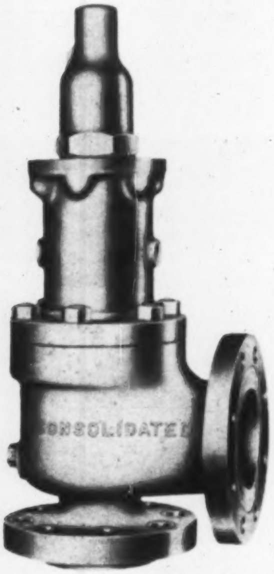
*Address*________________________

*City & State*________________________

CIRCLE 56 ON READER-SERVICE CARD

seal

CONSOLIDATED SAFETY RELIEF VALVE'S Sealing Bellows protects against damage from contaminants, corrosion, or viscous fluids



Consolidated Safety Relief Valves are available in both Balanced Bellows and Standard designs. The Standard type has an eductor tube that effectively removes bonnet pressure.

saves

Balanced Bellows Type Consolidated Safety Relief Valves have a durable, two-ply stainless steel Sealing Bellows that isolates and protects working parts from destructive elements in the lading fluid.

The bellows is balanced with the seating surface. Even with superimposed back pressure in the relieving system, valve performance is consistently stable and dependable. The bellows does not affect the high capacity of the valve, nor does it require change in set pressure. Even the blowdown adjustments are limited.

Additionally, Consolidated Safety Relief Valves now offer a no-leak tightness maintained by a resilient "O" Ring Seat Seal retained in the valve disc. This Seal assures tightness at operating pressures far closer to set pressure than with metal-to-metal seats alone, yet does not carry the seat load imposed by the spring. The Seal also takes piping strains much better than all-metal seating.

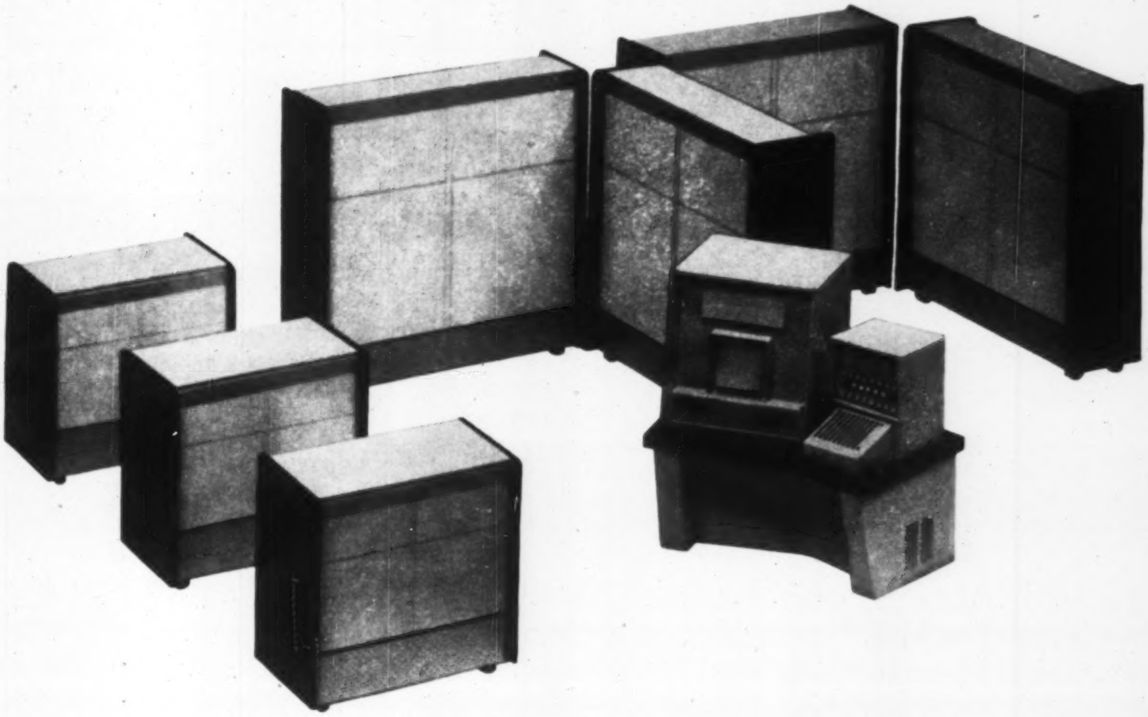
The Sealing Bellows and "O" Ring Seat Seal are typical of the extra quality built into Consolidated Safety Relief Valves to assure absolute protection for personnel and plant. These fine features plus flat seating and single ring construction also eliminate many maintenance problems and costs. Write for Catalog 1900 and Bulletin 1940.

MAXWELL
MANNING
M&M
& MOORE INC
TRADE MARK

CONSOLIDATED SAFETY RELIEF VALVES
A product of
MANNING, MAXWELL & MOORE, INC.
Valve Division • Tulsa, Oklahoma
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

CIRCLE 57 ON READER-SERVICE CARD

LFE's new RD-900 system--



. . . provides a random access file of up to 495 million bits with access to information in less than 3/10 of a second.

. . . may be operated with all standard general purpose digital computers, or as an independent storage, access and display system.

The RD-900 Random Access Storage and Display System, consists of from 1 to 33 high density, magnetic, file drums, each with a storage capacity of 15 million bits. A Symbol Generator converts coded characters into a visual message as fast as they are read from the file. One Symbol Generator is used to drive any number of output display devices. These include 21″ console displays and large screen projection displays . . . each capable of displaying up to 12,800 characters, symbols or a composite of both. In addition to alphanumeric characters the system can display arbitrary or abstract symbols, schematic or logical drawings, graphs, charts, and maps. Applications include military and industrial systems where information retrieval and display must be simultaneous for instant decision making. For a complete description and specifications write Dept. 101.

LFE

COMPUTER PRODUCTS
DIVISION

LABORATORY FOR ELECTRONICS, INC.

1079 COMMONWEALTH AVE. • BOSTON 15, MASSACHUSETTS

CIRCLE 58 ON READER-SERVICE CARD

ALDEN / *Building Block Electronics*

Plug for plug-ins

Alden basic building blocks give every engineer a faster, easier way to lay out and package electronic systems from off-the-shelf components. Here's the story in a nutshell.

Alden plug-in components simplify engineering, cut layout time, and speed production. These basic building blocks help you move faster from design idea right on through to completed equipment . . . beginning with planning and circuit layout.

The Alden terminal card mounting system

Alden's unique terminal card mounting system provides everything you need to make planning and layout quick and convenient: scaled layout sheets, pre-punched terminal cards, miniature terminals, card mounting tube sockets, jumper strips to eliminate wiring, brackets and tools — everything, and **all available from stock.**

What it adds up to is unit planes of circuitry, compactly and neatly organized, function by function as complete sub-assemblies, ready for packaging.

Packaging — the easy way

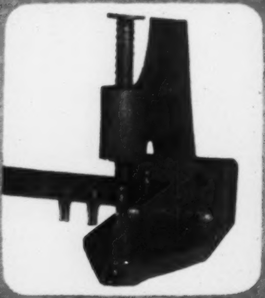
For packaging these card-mounted sub-assemblies, Alden provides a variety of basic, plug-in chassis in which circuitry is deployed in space saving vertical planes. These chassis plug in, lock, and eject with a half-turn of the wrist.

Housing — the easy way

You can house these plug-ins in your own standard racks. Or, Alden has basic "housing" units, called Uni-Racks which will help you there and give you a more compact, serviceable unit. Either mobile or stationary, they're of various heights, and offer easy accessibility, front or rear.

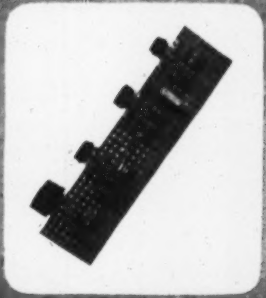
HERE'S HOW SIMPLE IT IS

Schematic is laid out, full scale, on Alden Terminal Card Planning Sheets.



Using planning sheets as masters, terminals and sockets are swaged and eyeleted securely into place on pre-punched terminal cards.

Components are snapped into terminal jaws, ready for soldering.



Terminal cards make neat component sub-assemblies, organized function by function into unit planes of circuitry.

The prime plus — serviceability

All along the way, Alden makes servicing and troubleshooting simple. Matter of fact, Alden modular construction is so simple, the user's own untrained personnel can locate and correct most troubles on the spot.

For instance: monitoring elements assigned to each plug-in unit, including tiny Alden tell-tales, pinpoint and isolate trouble instantly. With spares, no plug-in need be out of operation more than 30 seconds, since chassis lock and eject with a half-turn of the wrist. Color-coding, and fool-proof matching of mating components are two more of the many thoughtful innovations that enable any layman to make first level tests.

Get complete information — free

It doesn't cost you a cent to find out how Alden's basic building block system can help you solve problems faster . . . how Alden can help to free you from the mechanical chores associated with your job, so that you can spend more time doing what you're paid to do — **design.**

The coupon below has been specially designed to make it easy for you to get the specific information you need in a hurry. Take a moment to fill it out — now — and you'll receive, as a bonus, Alden's big 250-page handbook, "Ideas, Techniques, and Designs".

(Please fill out completely)

ALDEN
PRODUCTS COMPANY
10126 Main Street, Brockton 64, Massachusetts

TYPE OF ORGANIZATION
- ☐ Manufacturing Company
  - ☐ Commercial
  - ☐ Government
  - ☐ R & D
- ☐ Lab, School, Consultant
- ☐ Government Agency
- ☐ Jobber, Distributor, Manufacturers Rep.

CHIEF PRODUCT OR SERVICE ____________________

MY JOB:
- ☐ Administration
- ☐ Design Engineer
- ☐ Production Engineer
- ☐ Purchasing
- ☐ Sales

Please send me the following information:
- ☐ Alden Quick-Order Guide
- ☐ Facts on time and money-saving Alden "Get-Started" Kits ($11.50–$249.50)
- ☐ 250-page Alden Handbook

Name ____________________

Title ____________________

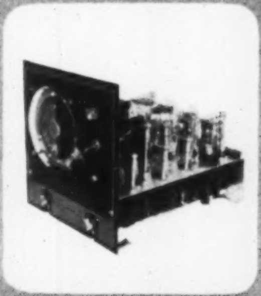
Company ____________________

Address ____________________

City __________ Zone __________ State __________

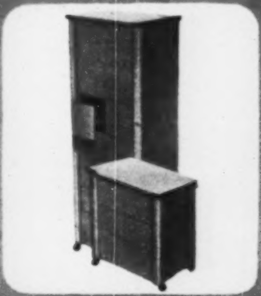
CIRCLE 59 ON READER-SERVICE CARD

Card-mounted circuitry is snapped in or bracket mounted to pre-punched, pre-shaped chassis.

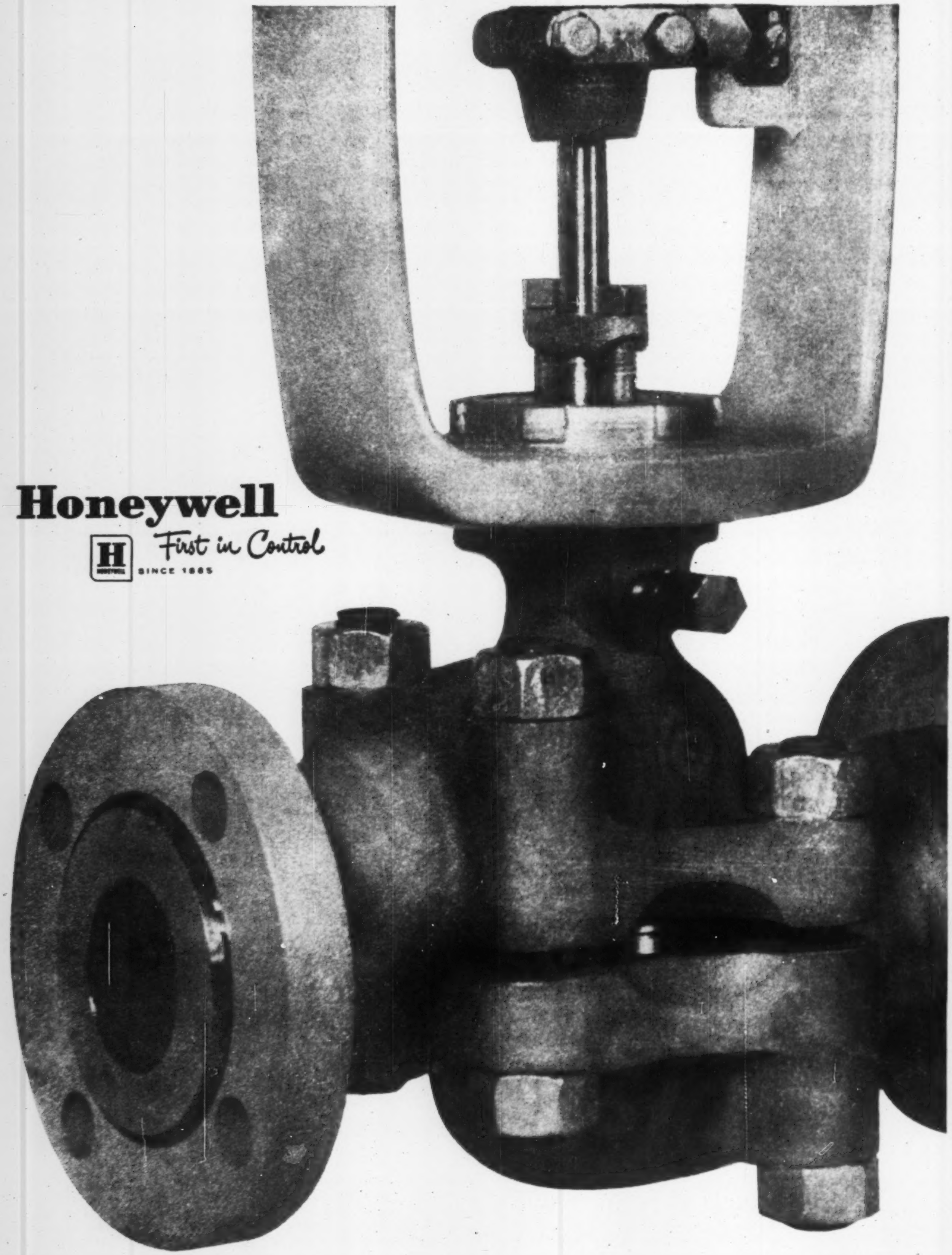


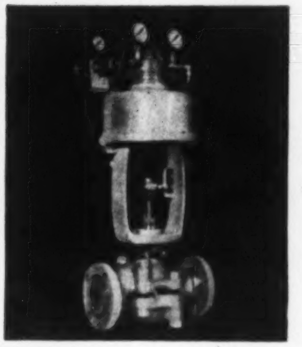
Basic chassis, with sub-assemblies in place, provides for fast, easy accessibility. Simple half turn of special Serve-a-Unit lock guides, locks or ejects for easy service checks, repairs, or 30-second replacement.

"Picture Frame" rack adaptor accommodates any combination of basic chassis, mounts in any standard rack or Alden Uni-Rack.

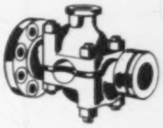


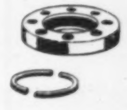
Alden Uni-Rack available in two basic heights, easily accessible front or rear, mobile or stationary. Adjustable height—panels fit flush.

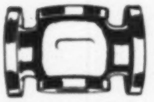

Honeywell
First in Control
SINCE 1885

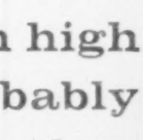


Now, a new split-body valve makes possible a flexible intermix of Honeywell valves and actuators—a combination designed for both economy and perfect matching of valve to application. For example, you can get the split-body valve with cost-cutting, clamped-in seat rings, separable flanges and the new cylinder actuator. Or perhaps your application calls for the split-body with fixed flanges and the economical diaphragm actuator. With high temperatures, you'd probably prefer this globe body valve, with either the cylinder or diaphragm actuator. In any case, the completeness of the Honeywell line lets you select the valve-actuator combination that's exactly right for the job... without pushing a valve beyond its design limits, without paying for more than you need. Write for Bulletin B-802-1.







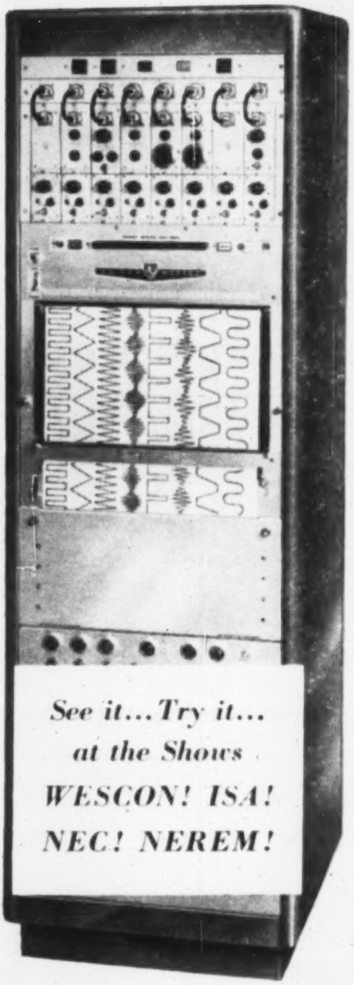


75th YEAR PIONEERING THE FUTURE

Minneapolis-Honeywell, Fort Washington, Pa.

CIRCLE 60 ON READER-SERVICE CARD

Here's why the NEW AO TRACE-MASTER is the world's finest 8-channel direct writing recorder!



American Optical Company, famous for precision instrumentation for 138 years, introduces an electronic direct-writing recorder of unique design, in which ultra-precise electromechanics has been combined with advanced electronics to achieve *truly superior performance.*

Finest Writing Method Ever

Unique direct-carbon-transfer writing method. Trace is uniformly black and up to four times thinner than that made by any other recorder. Minute variations in phenomena measured are more faithful, meaningful. Carbon trace cannot fade... may be easily reproduced.

Finest Frequency-Amplitude Performance

TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response *at larger amplitudes* than any other recorder. TRACE-MASTER response is flat—*within 1%*—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

Finest Chart-Drive Facilities

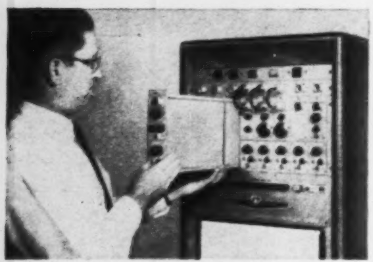
TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

Finest Resolution, Linearity, Stability

Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity (± 1%) and stability in rectilinear presentation permit full use of this unexcelled resolution.

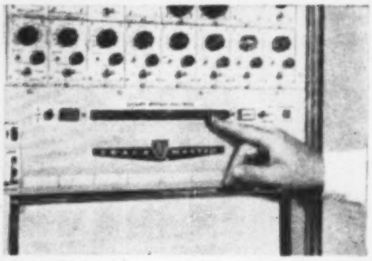
Finest Systems Oriented Compatability

Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.



Entire channel easily accessible and completely interchangeable as single unit.

Platen tilts to convenient writing angle.



Widest range chart speed... push-button selection through 0.1 mm/sec to 500 mm/sec.

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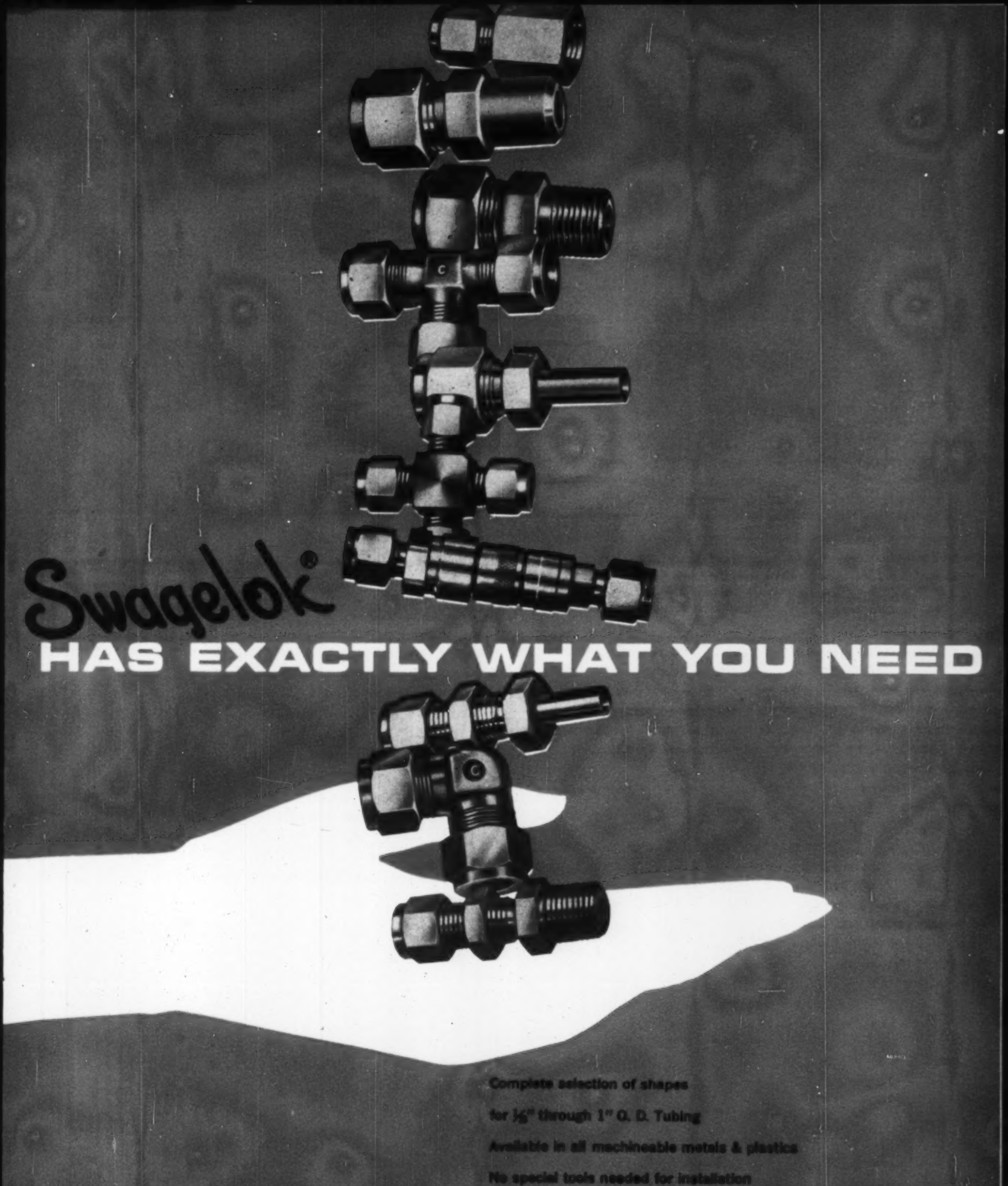
CIRCLE 61 ON READER-SERVICE CARD



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1¼ turns provides torque-free vacuum tight seal

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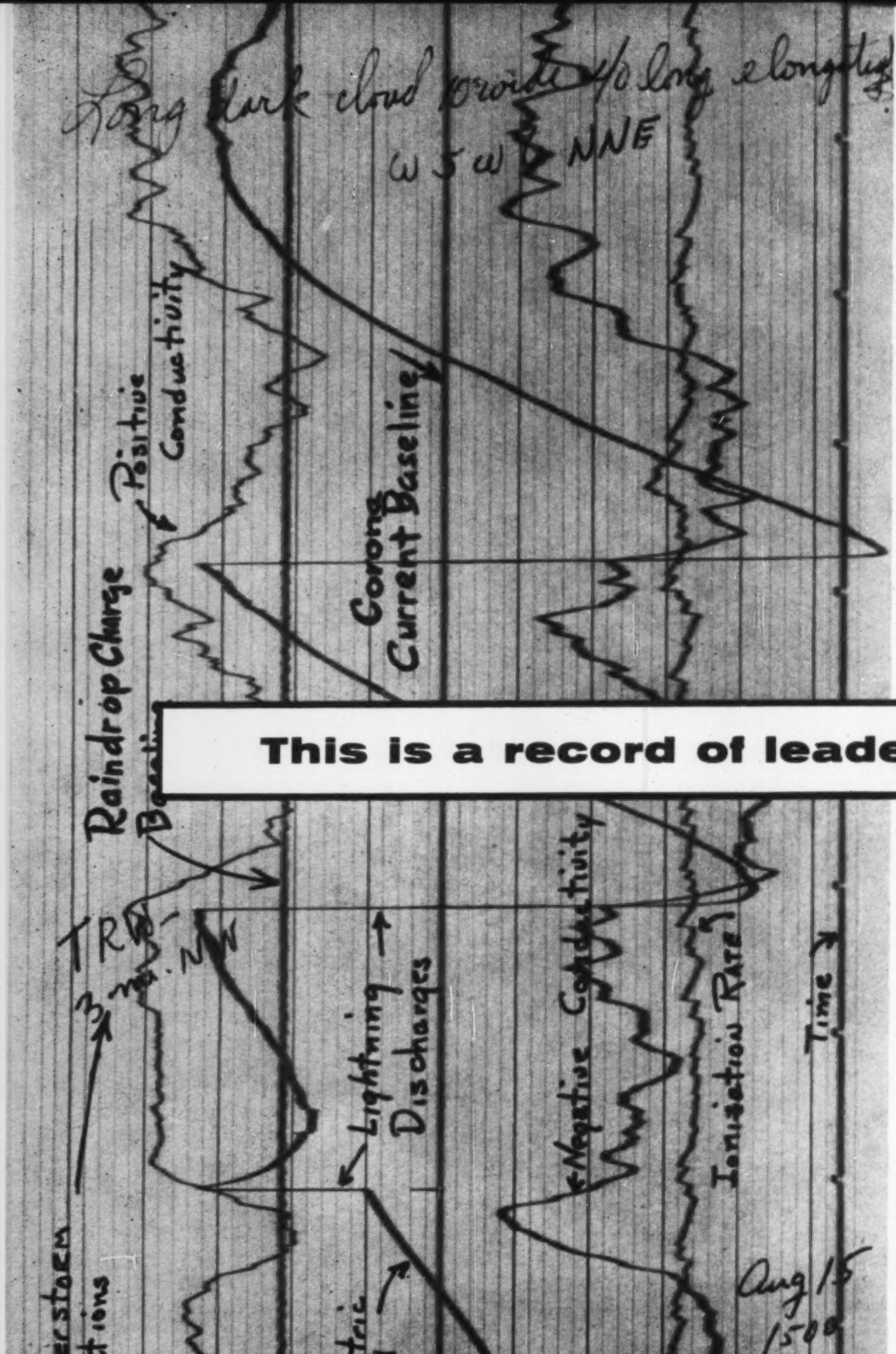
This is a record of leadership



Honeywell 906A Visicorder record, actual size. Note longitudinal grid lines

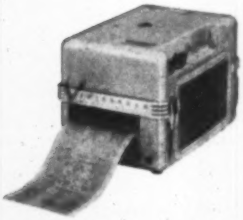
The U.S. Weather Bureau used a Honeywell Model 906B Visicorder Oscillograph to record directly this diary of a thunderstorm as it passed near the observation station on Mt. Washburn in Yellowstone National Park.

As the storm passed, the Visicorder measured and recorded 1) positive and negative electrical conductivity of the air, 2) the rate of ionization of air due to airborne radio-active particles and extra-terrestrial radiation, 3) the size and charge of individual raindrops, 4) the corona discharge current from an insulated tree and from a 4'x 6' grass plot to determine current flow from the earth's surface to charge centers in the clouds, 5) times of camera exposure photographing cloud droplet size and electrical charge, 6) atmosphere potential gradient, and 7) time.

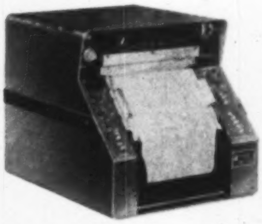
The Visicorder made this and many other records on Mt. Washburn without the use of power amplifiers. This feature, plus the extreme portability of the Visicorder, made it the ideal oscillograph for use in these studies.

Byron Phillips, U. S. Weather Bureau Scientist, monitors thunderstorm data as it is recorded by the Honeywell Model 906 Visicorder.

in weather research



Recent Models of the **906 Visicorder** incorporate time lines and grid lines and record up to 14 simultaneous channels of data.



The NEW Model **1108 Visicorder** with many automatic features and the convenience of push-button controls, is ideal for intermediate uses requiring up to 24 channels of data.

The Model **1012 Visicorder** is the most versatile and convenient oscillograph ever devised for recording as many as 36 channels of data.

The Honeywell Visicorder is the pioneer, completely proven, and unquestioned leader in the field of high-frequency, high-sensitivity, direct-recording ultra-violet oscillography. Here are some of the reasons why Visicorders provide the most accurate analog recordings available: constant flat response and sensitivity of galvanometers; grid-lines simultaneously recorded with traces to guarantee exact reference regardless of possible paper shift or shrinkage; flash-tube timing system for greater accuracy of time lines; superior optics for maximum linearity of traces.

No matter what field you are in . . . research, development, computing, rocketry, product design, control, nucleonics . . . the high-frequency (DC to 5000 cps) Visicorder Oscillograph will save you time and money in data acquisition.

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: write for Bulletins 1108, 1012 and HC-906B
Minneapolis-Honeywell Regulator Co.
Industrial Products Group, Heiland Division
5200 E. Evans Avenue, Denver 22, Colorado

Honeywell

Industrial Products Group

FROM HONEYWELL... A DIAMOND JUBILEE PARADE OF PRODUCTS

CIRCLE 63 ON READER-SERVICE CARD

Make speedier checks of recorders, controllers and base or noble metal thermocouples in industrial plants with the new three-dial 8686 Portable Millivolt Potentiometer. Features such as a central reading window . . . where measured values appear as a row of digits with a scale interpolation . . . simplify calibration of thermocouples and test measurements. The 8686 Potentiometer has: a wide operating range of −10.0 to +100.1 mv and +1010 to +1020 mv for standard cell calibration; and a high accuracy of ±(0.05% of reading +3μv) without reference junction compensation, ±(0.05% of reading + 6 μv) with ref. jct. comp. Write for Data Sheet E-33(1A).

8686 Millivolt Potentiometer

8690 Millivolt Potentiometer

Fast, accurate in-plant checking of thermocouples, recorders and controllers is expedited by the new 8690 Portable Millivolt Potentiometer. Design features such as "Inline Readout", which permit measured values to be read in digits with a scale interpolation, accelerate temperature measurements. The 8690 provides a wide range of −11.0 to +101.0 mv which eliminates input reversals; an accuracy of ±(0.05% of reading + 20 μv) without reference junction compensation, ±(0.05% of reading + 40 μv) with ref. jct. comp. Write for Data Sheet E-33(1B).

4 time-saving instruments from the

NEW

CONVENIENCE-STYLED L&N LINE . . .

8692 and 8693 Temperature Potentiometers

If you want to make a variety of temperature measurments quickly with one flexible instrument, investigate the new time-saving 8692 Single-Range or 8693 Double-Range Temperature Potentiometers. Available in any of 24 interchangeable temperature and millivolt ranges, these instruments read directly in degrees F or C on a scale 27½" long. Convenience features include: simplified range changes . . . only a screwdriver is needed to change a circuit panel, scale and binding post studs; automatic reference junction compensation . . . reference coil, built into circuit panel, compensates for thermocouple being used; accuracy . . . ±0.2% of range. Write for Data Sheet ND42-33(1A).

Need a fast-operating, high-sensitivity, high-quality null indicator for use in research, testing and production checking? Here's a new 9834 Guarded D-C Null Detector having a short period of less than two seconds for source resistances up to 1000 ohms, increasing to 4 seconds at 100,000 ohms . . . ideal for measurements with guarded or unguarded potentiometers and bridges. Of rugged construction, this portable, line-operated detector provides numerous convenience features which include four degrees of sensitivity, with a basic sensitivity of 0.2 μv/mm (0.3 μv/scale div.), and a noise level of less than ±0.1 μv. Write for Data Sheet ED7(2).

9834 Guarded D-C Null Detector

LEEDS NORTHRUP
4955 *Stenton Ave., Philadelphia 44, Pa.*

CIRCLE 64 ON READER-SERVICE CARD

THE 15th ANNUAL ISA CONFERENCE & EXHIBIT

WAS HELD SEPT. 26-30, 1960 at the New York Coliseum. The attendance (16,000) and total exhibit area was less than predicted by a sizable factor, but the technical-session attendance exceeded expectations. The Standards and Measurements sessions, in particular, had to be moved into larger rooms to accommodate the crowds.

The emphasis on standards and measurements was high in the sessions—but low on the exhibit floor. The exhibits were predominately heavy industrial and process control, with far fewer exhibits—compared to previous years—in the fields of analog computation, digital instrumentation, components, test instruments, and standards instruments.

An extremely interesting meeting was held on Tuesday morning, Sept. 27, to investigate the need for an "Association of Standards Laboratories." Attending were men in charge of standards and calibration for NBS, AVCO, Bendix, Sperry, and other large organizations, plus officials of the ISA and the Precision Measurements Association. The discussion involved the problems of standards laboratories, including certification of laboratories, terminology, traceability of standards, etc. But no conclusion was reached as to the need for a separate Association of Standards Laboratories.

The exhibit had many novel disclosures for instrument men, including the following:

DATA HANDLING AND COMPUTING

New techniques for recording data were disclosed by (1) Keinath Instrument Company, whose K-Logger uses the Keinath sweep-balance technique to place up to 400 analog curves on one large chart, and (2) American Optical, whose Tracemaster obtains direct-writing of a 40-mm signal of up to 110 cps by carbon transfer, using pen-motors rather than galvanometers.

Libratrol unveiled the 1000 control computer, its first showing.

Bailey Meter unveiled its 750 logging systems, featuring magnetic-drum programming (rather than conventional patchboard programming).

Foxboro exhibited the RCA 110 computer-control system, and also electronic analog computing elements, including the T/637 for pressure and temperature compensation of flow signals.

General Electric exhibited its 312 digital control computer.

In tape handlers, Honeywell disclosed the LAR 7500 (which can record to 20 kc for ½ hr on one reel), and Consolidated Electrodynamics disclosed the VR2600 DataTape (recording from 300 cps to 500 kc direct, dc to 40 kc FM), An interesting use of tape was shown by Mnemotron Corp.—a small tape recorder which uses PFM to record any analog signal and reproduce it later as a curve at any desired time base.

Consolidated Electrodynamics also introduced a portable direct-writing oscillograph.

Epsco disclosed an important educational tool, a "digital trainer" that shows how circuits are designed by symbolic logic.

ELECTRONIC AND TEST INSTRUMENTS

The show had far fewer test instruments than in past years. Fairbanks, Morse & Co. introduced a complete line (EMI, Ltd) including radiation detectors, stroboscopes, oscilloscopes, and weighing equipments. Transistor Specialties introduced a precision frequency pulse generator and an APTI (Actions Per Time Interval) Meter with digital readout, which accepts 10-mv rms signals.

Trans-Sonics introduced a precision d-p meter sensitive to less than 0.1 micron (using capacitance change as the sensor.)

Haas Instrument Corp. revealed new primary secondary pressure standards (standard barometers) and pressure controllers for pressure calibration work.

Control Indicating Corp. disclosed controlled temperature baths for calibration work, accurate to 0.1°F from 0 to 100°F.

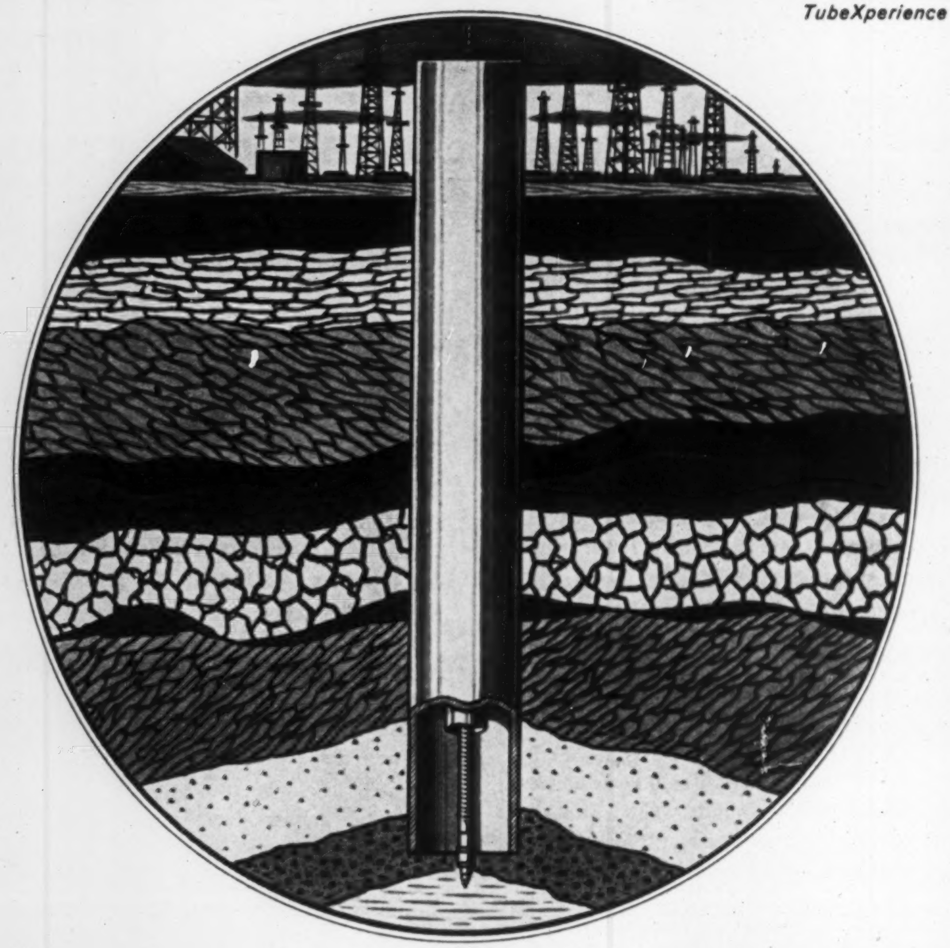
LOST—En Route to Pontiac, Ill.

On September 1, Railway Express picked up the editorial copy for our 1961 Buyers' Guide listings, for delivery to our printer. That's the last we saw of it—and the printer still hasn't received it!

Railway Express blames the PRR strike. We have no time to blame anybody, if we're to get the Guide done—again—in time for November (instead of October) publication.

You will receive your 1961 ICS Buyers Guide with your November issue, instead of this October **issue.**

TubeXperience in Action



Deep well pressure readings within .05% accuracy with help of Superior Ni-Span C* Bourdon Tubing

Accurate down-well pressure readings, indicating changes of only 1 to 4 psi at bottom-hole pressure of 2000 psi, are hard to get, but extremely important. They demand a pressure gage accuracy of at least 0.1% to make the vital engineering calculations based on them of any value.

To achieve this accuracy and better it, Superior was asked for help in selecting the Bourdon tube material for an improved bottom-hole measuring device. After careful study, its metallurgists recommended Ni-Span C nickel-chrome alloy for the Bourdon tubes. This material was chosen for its relative insensitivity to temperature changes, coupled with superiority in operating temperature, mechanical hysteresis, and elastic drift; also for its fatigue resistance and spring properties.

The customer followed the suggestion and now this gage, which is unique in bottom-hole pressure instruments for the reason that it utilizes a helix-wound Bourdon tube to transmit directly the effects of pressure to a recording stylus, is rated 0.1% accurate. In fact, with special care in operations and calibration, it can measure within .05% accuracy.

NI-SPAN C TUBING NOW STANDARD AT SUPERIOR

Ni-Span C redraw stock is now in inventory at Superior, available for immediate production in a range of sizes from .010 in. to ⅝ in. OD, up to .125 in. wall max., and from ⅝ in. to 1⅛ in. OD in wall thicknesses up to .035 in. max. Shaped tubing can be produced to customers' prints. Perhaps you have an application that can benefit from its unusual properties. Write for Data Memorandum No. 19. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

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Superior Tube

The big name in small tubing

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All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

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CIRCLE 65 ON READER-SERVICE CARD

15th ISA Show

INDUSTRIAL AND PROCESS INSTRUMENTATION

The major area of the exhibit was devoted to industrial and process exhibits:

Leeds & Northrup disclosed the "Controll-All," a unit incorporating all of the many L&N control modes so that the user can select the best control mode for the problem.

deVar Systems introduced a complete new line of electronic general-purpose process-control equipments using 0.5 mv signal and featuring battery reserve(if power fails, system still operates).

Bailey Meter introduced a new force-balance pressure transmitter using a Bourdon movement. This is the first time that force (rather than displacement) of bourdon element has been so used, permitting suppressed-range operation.

Hays Corporation also introduced a 3-mode electrical control system with 1-5 ma input signal, 10-50 ma output signal.

Bristol unveiled a 4" metagraphic pneumatic receiver.

Foxboro's new auto-selector can control from either of several high or low variables.

Barber-Colman has added infinitely adjustable zero suppression and adjustable span to its standard potentiometer.

Decker unveiled the 600 Gyroflo mass flowmeter.

Brooks Instrument disclosed a new level transmitter with pneumatic or electric output, using its basic magnetic follower principle; also corrosion-resistance straight-through flow rotameters.

Barton Introduced a new electrical transmitter for flow, level, etc., featuring large output via built-in magamps.

San Diego Scientific revealed its Magne-Alarm, an all solid-state monitor for low-level signals, also featuring magamp input.

Curtiss-Wright introduced an interesting and large line of transistorized controllers based on moving-coil movements, with proportional plus reset modes, all available in its standard recorder unit; also a 3-movement dynamometer.

Assembly Products introduced a miniature temperature recorder (less than $200) plus controlling multimeters using its meter-relay principle.

In the valve field, General Controls revealed a proportional-action electro-hydraulic Hydramotor and linear actuators for plug-cocks. Annin introduced a line of vacuum-jacketed valves for liquid hydrogen and self-draining valves. Manning, Maxwell & Moore showed safety relief valves with O-ring seat seals for zero leakage.

Continental Sensing developed much interest in its line of long-length thermocouple sensors and heaters, featuring BeO thermocouples and rhenium-tungsten thermocouples for use above 3000°F. On display was the first tc to reach 4000°F in an oxidizing atmosphere (Mb-coated sheath plus Ir-Ir-Rhodium couple).

Winslow Electronic Gaging Division introduced an "electronic gage" using an IRC diff-tran to measure dimensions, plus digital readout, plus autoprogramming (24 channels).

ASCOP unveiled a new metal detector using eddy current plus inductive effect to detect ferrous or nonferrous metals.

Statham introduced a miniature flush-diagram absolute-pressure transmitter.

EDITORIAL

THE DIGIT

THE future of the digit is bright; the digital field bubbles over with optimism; the prospects for digital equipment of all types—counters, readout meters, multiplexers, converters, printers, loggers and computers—can only be described as glorious.

There are several reasons for this situation. One is the power of the digit—it is the final result of almost all measurements other than trend curves. A second reason is the speed of the digital computer. A third is the vast amount of money spent on all digital techniques in the various military programs. A fourth is the glamor of the computer-controlled future and the machine that reads, learns, adapts itself to conditions, optimizes, and never relaxes. A fifth is the tremendous publicity given this glamorous concept by the press, both lay and technical.

An important sixth reason is the fine cooperation and spirit that prevades the digital field. For example, in Pittsburgh, Pa., on August 10, 11, and 12, more than 200 users of the Bendix G-15 general-purpose digital computer met at their fifth national meeting, called EXCHANGE, to exchange experiences, views, and programs. Most of these men were competitors—but here they were, telling each other how they analyzed and solved problems in terrain, water resources, channel design, shell analysis, structural engineering, chemical engineering, etc.; 150 new programs were submitted to the library; more than 500 programs use distributed to the members. It was a wonderful program—and another reason why the future for the digit is so bright.

Analog-Computer users might well look at the digital "exchange" programs.

Epsco-West NEWSLETTER

To go,
or
not to go?

Epsco-West Systems Help Checkout Atlas Missile

Recently Epsco-West put its solid state know-how to work on four identical systems which simultaneously time and monitor the operation of 50 microswitches for operational checkout of the Atlas missile at Vandenburg Air Force Base.

If any of these switches happen to be in a "no go" instead of a "go" condition at the end of a switching sequence, a printer prints out the code number of the faulty circuit.

Epsco-West used solid state circuit elements throughout. Each system contains 250 transistorized plug-in circuit cards. Eight of the 12 logic circuits, comprising 90 percent of the system, are *standard, off-the-shelf* components. Like all Epsco-West systems, those delivered to Convair Division of General Dynamics feature:

* *Reliability* * *Compactness*
* *Low Power Dissipation* * *Low Maintenance*

HOW IT WORKS

Switches are timed by counting 400 cps from a standard power supply on binary coded decimal counters. This establishes a real-time reference for simulating correct switch operation. Continuous comparison of the internally stored program to actual switch operation determines the "go" or "no go" condition.

To make this comparison, individual sensing circuits for each switch determine both the normal and the undesirable switch actuations. If a "no go" condition should exist at the end of the switching sequence (ranging from a few tenths of a second to approximately 3 minutes), a remote comparator and control unit identifies the circuit involved. A printer then prints the code number of the faulty switch circuit.

Epsco-West
First in Data Control
A Division of EPSCO Inc., Cambridge, Mass.

We would be happy to show you how Epsco-West can produce data control systems faster and with far fewer components. Call your nearby representative, or write for the free new Epsco brochure, "First in Data Control." Please address Dept. 54.

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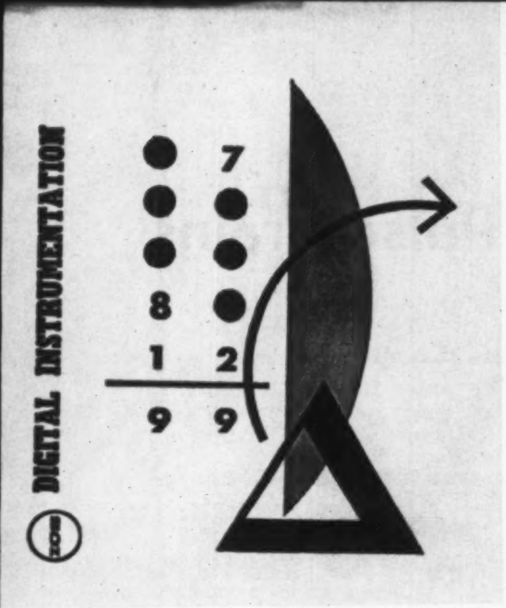
5A

CIRCLE 66 ON READER-SERVICE CARD



Frequency Counter

ROSS E. HUPP, Erie-Pacific Division, Erie Resistor Corp.

This frequency counter uses count-down technique to obtain direct-reading accuracy of a low frequency (400 cps) to 1 part in 40,000, without waiting for 40,000 counts (cycles).

A PROBLEM in counting intervals and frequency is that high accuracy usually requires a high count, and hence a long time interval. For example, in order to measure a frequency of 400 cps to an accuracy of 0.01 cps (400.01 or 399.99), it would be necessary to obtain 40,000 counts in order to observe a change in the fifth place. Thus 100 seconds would be required to obtain this accuracy.

The counting technique used in this frequency monitor* (Fig. 2) uses a sensing device that counts N events of the frequency to be measured, and opens a gate for this interval. While the gate is opened, signals from a clock of higher frequency are passed to an indicating counter. If the frequency to be measured is 400 cps, and if the clock frequency is 100 times that of the frequency to be measured (say 40,000 cps), then 40,000 counts can be obtained in only 1 second. Now the frequency of the source to be measured can be indicated to 0.01 cps in 1 second.

The instrument is made direct-reading in frequency by having the readout counter preset to a high count (80,000 for a 400-cps measurement), and then counting *down* instead of up. This is because pulse frequency and pulse interval are inversely related ($F = 1/T$). That is, the higher the frequency to be measured, the shorter the time for the N cycles of that frequency to occur. Hence the counter, which is counting down, will indicate a higher number, as desired.

If the frequency is exactly at 400 cps, the counter will count down from 80,000 to 40,000, and will indicate 400.00 cps.

If the frequency is high by 0.01 cps, then the counter will count down from 80,000 to only 40,001, and will indicate 400.01 cps.

If the frequency is low by 0.01 cps, then the counter will count down from 80,000 to 39,999, and will indicate 399.99 cps.

Due to the nonlinear shape of the curve of $F = 1/T$, the accuracy of the reading decreases as the monitored frequency moves away from the desired value. Accuracy also depends on the stability of the clock oscillator used. In the Model 660 low-frequency monitor shown, the accuracy is ±1 count ± crystal stability, or 0.0035% maximum error at 400 cps. Within 4 cps of this frequency, the accuracy is ±0.01%; within 20 cps of this frequency the error is less than 0.3%. However, a calibration table can be used to obtain a more accurate reading, if desired.

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*Patent 2,993,644, April 19, 1960 Ross E. Hupp, assigned to Erie Resistor Corporation.

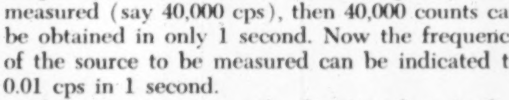


FIG. 1. MODEL 660-400 400-cps frequency monitor.

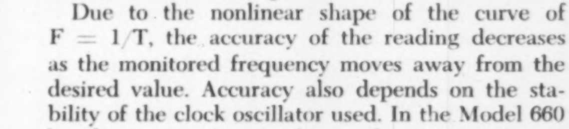
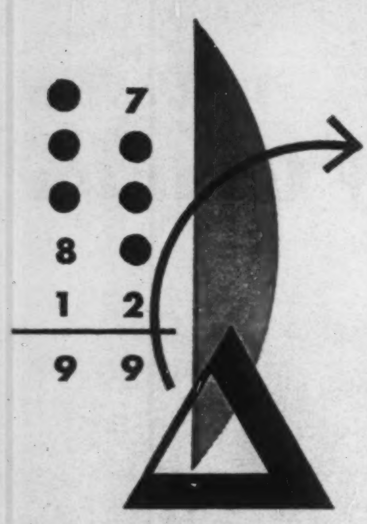

CLOCK
GATE OPENS FOR N EVENTS
PRESET COUNTER COUNTS DOWN FROM PRESET NUMBER
DISPLAY
PICKUP FOR COUNTING N EVENTS
GATE CONTROL

FIG. 2. ELEMENTS of frequency monitor.



Dividing Pulse Trains

Here are eight circuits that divide a series of pulses. The pulse train is divided by 2, 3, 4, 5, 6 or 7.

WILLIAM P. HORTON, Computer Control Co.

DIVIDING CIRCUITS accept a pulse train, or a series of pulses, and produce an output each time a predetermined number of pulses has been received. Counters are dividing circuits; a decade counter is a divide-by-ten circuit. These pattern generators are more commonly called *shift counters;* perhaps a better title for the circuits shown here is *delay-line counter* because only delay lines and an AND gate are used in each circuit. Figs. 1-6 show delay-line counters using standard PAC* packages.

When power is first applied to a PAC the outputs are 0 at the assertion (+) output, and 1 at the negation (—) output (Fig. 1). Hence the 1 on the negation feedback will combine with the first pulse, and the AND gate at the left in Fig. 1 will produce an output.

One microsecond later this pulse appears as a 1 at the assertion (+) output. Now the negation (—) output is 0, thus inhibiting the next (second) clock pulse. The negation output returns to 1 before the third clock pulse. Thus the third pulse is passed; the fourth is blocked; the fifth is passed; etc. Every other pulse is passed to the assertion output. The 1-Mc clock is wired internally to every AND gate; it is shown in Fig. 1 but is not shown in the other illustrations.

Fig. 2 shows a divide-by-three circuit. The action is similar to that of Fig. 1. The first clock pulse (not shown) is passed by the left AND gate because both other active inputs, taken from the negation side, have a 1 signal present. The second clock pulse is blocked, as in Fig. 1, because the first negation output becomes 0. The additional delay sends a 0 signal back to the AND gate at the third clock pulse. The fourth clock pulse, however, is passed through the circuit, because both negation outputs are again 1. Thus two pulses are blocked and one passed; every third clock pulse is passed through to the assertion (+) output.

Two divide-by-four circuits are shown in Fig. 3. A shows the circuit that acts similarly to that shown in Figs. 1 and 2. One additional delay is used so that three clock pulses are blocked each time one gets through. Thus the assertion (+) output becomes 1 only on every fourth pulse.

Fig. 3B shows a divide-by-four circuit that saves one delay unit. The AND gate at left passes two clock pulses, blocks two pulses, passes two, etc., because of the two delay lines. However, it is only after the first, fifth, ninth, thirteenth, etc., clock pulse that *both* output lines have a 1 signal. After

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*This is a commercial gating and logic element, comprising four AND gates, one OR gate and two delay units. A 1-Mc clock input is connected internally to each AND gate, in addition to the inputs shown.

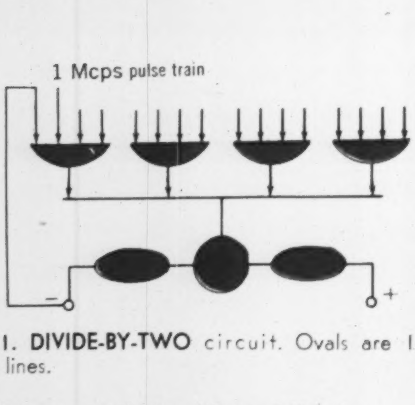

FIG. 1. DIVIDE-BY-TWO circuit. Ovals are 1-μsec delay lines.

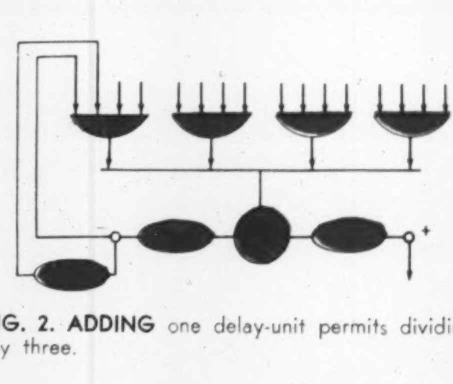

FIG. 2. ADDING one delay-unit permits dividing by three.

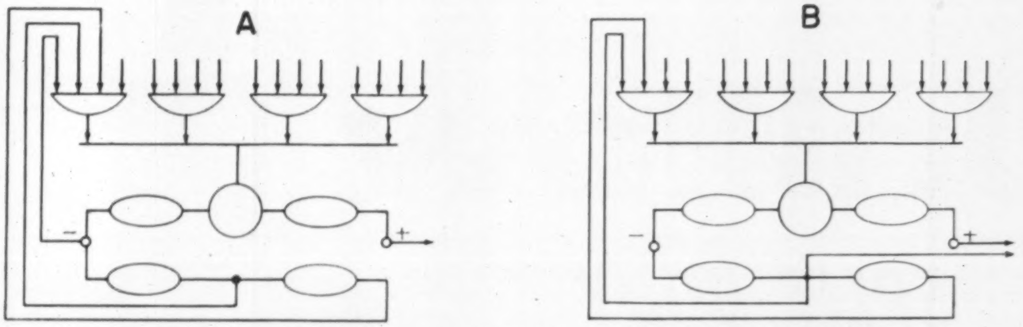

FIG. 3. A shows divide-by-four circuit with single output. B shows divide-by-four circuit with two output lines where both lines have 1 signal every fourth pulse.

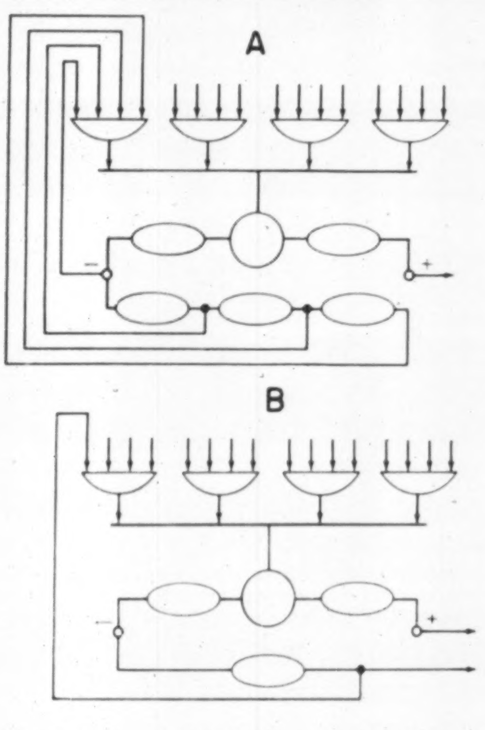

FIG. 4. A shows divide-by-five circuit with single output line. At B, a 1 signal is on both output lines after every fifth clock pulse.

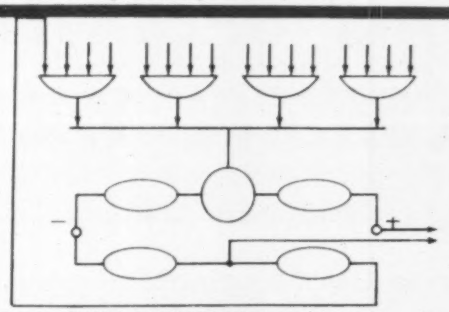

FIG. 5. TWIN-OUTPUT-LINE divide-by'six circuit has 1 signal on both output lines every sixth clock pulse.

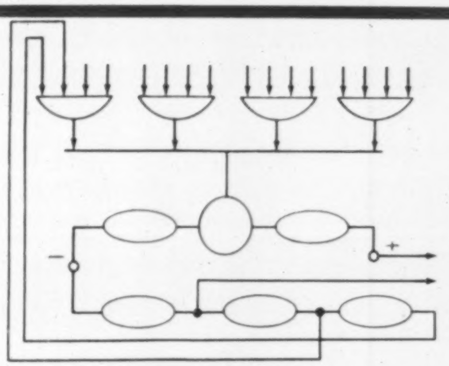

FIG. 6. TWIN-OUTPUT-LINE divide-by-seven circuit has 1 signal on both output lines every seventh clock pulse.

the second clock pulse, the 0 signal from the negation side appears on the second output line. These two output lines can drive an AND gate in the next stage, which then has an output only every *fourth* clock pulse.

Fig. 4 shows similar alternative solutions to dividing by five. A shows use of 4 delay lines that block the left AND gate for four clock pulses after a pulse gets through. Thus the assertion output has a 1 signal every fifth pulse.

One less delay unit is used in Fig. 4B. A 1 signal appears on *both* output lines only once every fifth clock pulse—after pulse one, six, eleven, sixteen, etc. Again, an AND gate in a following stage would produce an output only when the 1 signal is on both lines.

If the first feedback line is left off the divide-by-five circuit, it divides by six (Fig. 5). Here three clock pulses are passed before the 0 signal from the negation side is carried back to the AND gate input. Then three 0 signals arrive in sequence; blocking the left AND gate. When these feedback 0 signals are exhausted, three more pulses are passed by the gate. Again, it is only after the first pulse, and the seventh, thirteenth, etc., that there is a 1 signal on both output lines.

The divide-by-seven circuit (Fig. 6) uses one more delay unit to block the input AND gate one more time before it can again pass clock pulses. The AND gate passes three pulses, blocks four, passes three, etc. Both output lines have a 1 signal only after the first, eight, fifteenth pulse, etc.

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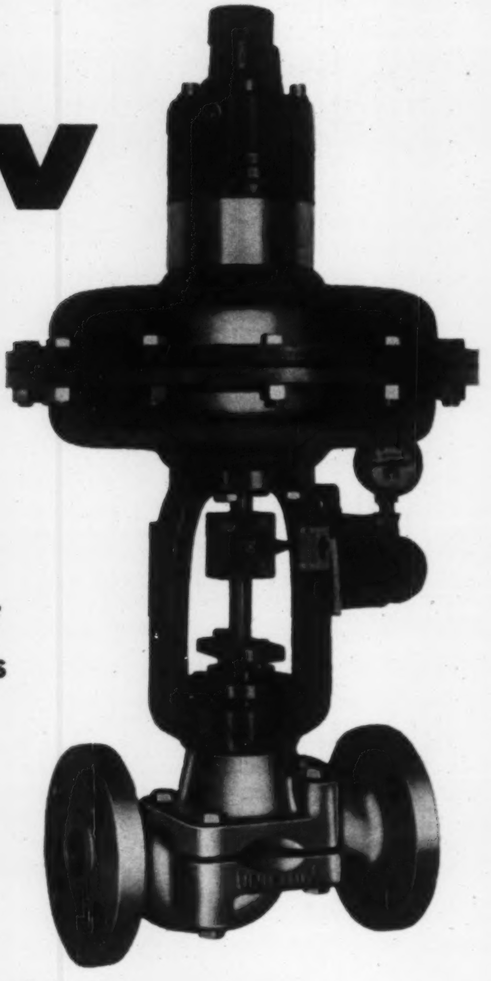

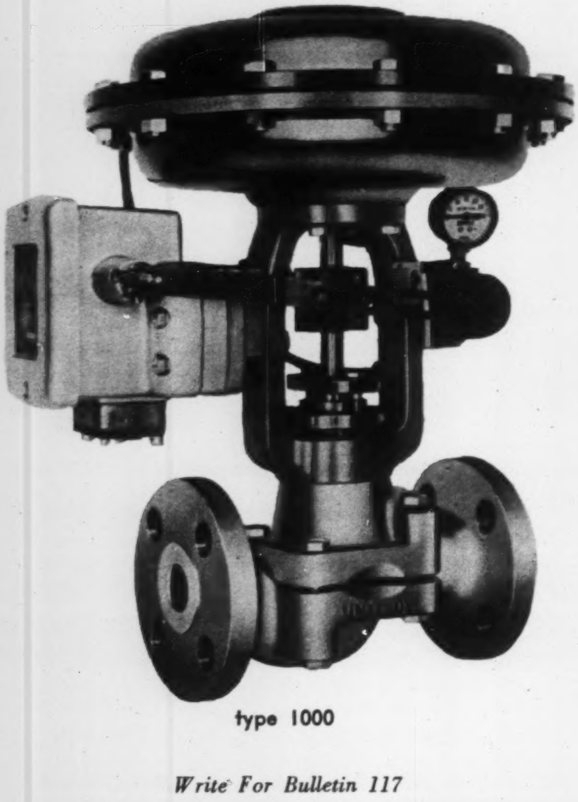

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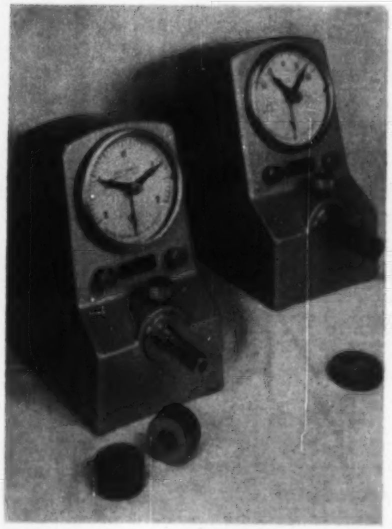

PNEUMATIC GAGING

DAVID B. KIRK, Moore Products Co.

Pneumatic gaging is a rapid inspection technique in which workpiece dimensions are compared to the dimensions of highly accurate ring and plug master gages. The instruments are high dependable —and their accuracies are not affected by surface wear, the human element of "feel," or grit and coolant on the work. Here are the principles and practice, including types of gage heads and indicators.

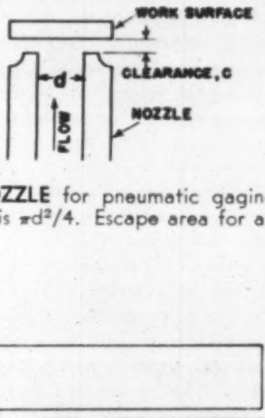

FIG. 1. NOZZLE for pneumatic gaging. Area of nozzle bore is $\pi d^2/4$. Escape area for air is $c\pi d$.

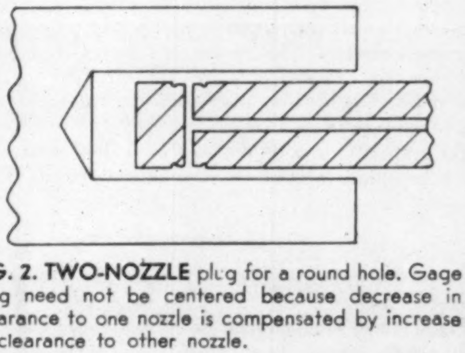

FIG. 2. TWO-NOZZLE plug for a round hole. Gage plug need not be centered because decrease in clearance to one nozzle is compensated by increase in clearance to other nozzle.

PNEUMATIC GAGING measures the proximity of a surface by a jet of air directed toward it through a nozzle which never touches it. The air pressure in the gage has a well-defined relation to the clearance between gage and surface, and hence the pressure measures the dimension.

Absence of mechanical contact provides long gage life and makes it possible to measure soft or highly polished surfaces (which would be deformed or damaged if hard mechanical contacts were used). There are no moving mechanical parts. The element can measure relatively inaccessible dimensions, such as the diameters of small deep holes. A number of gaging elements can be combined in a single body to measure several dimensions of a part simultaneously—for example, diameter, taper per inch, and over-all length.

Pneumatic gages are *comparators*. For set-up and calibration, highly accurate master gages are placed over the measuring nozzles—in the position that will subsequently be used for production workpieces.

As the gaging element is connected to the indicating mechanism only by an air passageway, which may be several feet in length, the indicating unit can be located with greater latitude and flexibility than in mechanical types of gages. When several dimensions of a part are measured simultaneously, this feature permits mounting all of the indicators in a compact group which can be scanned quickly.

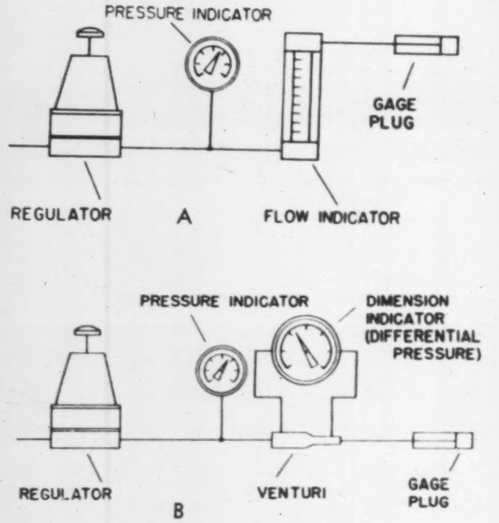

FIG. 3. FLOW-TYPE pneumatic gages. A uses rotameter to measure flow. B uses venturi and differential indicator.

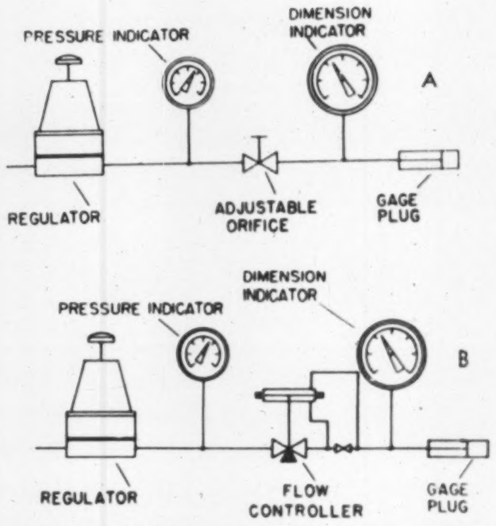

FIG. 4. SYSTEMS based on pressure measurement. A uses orifice followed by pressure gage (calibrated in dimension to be measured). B uses a constant-flow controller.

Operating Principle

The air leaving the nozzle must escape through the annular passageway formed between the nozzle and the work surface. The area which determines the flow is shown in Fig. 1 as a cylinder having a diameter (d) equal to the bore of the nozzle, and a length (c) equal to the work-to-nozzle clearance.

If air at a constant pressure of 25 psig is supplied to the nozzle, and if the clearance is small, the flow of air has a linear relationship to clearance. As the clearance increases, the annular escape area ($c\pi d$) eventually becomes equal to the cross-sectional area of the nozzle bore ($\pi d^2/4$). At this point

$$c\pi d = \pi d^2/4$$
$$c = d/4$$

This says (assuming a linear relationship between flow and clearance) that when the clearance is equal to one-quarter of the nozzle diameter the flow equals that through the unrestricted nozzle. Further increase of the clearance would have no effect on flow. As the gage works on the principle that clearance must affect the flow, the usable clearance must not exceed one-quarter of the nozzle-bore diameter.

In gages using a single nozzle, the workpiece must be mechanically positioned, as against a surface plate, so that the surface to be measured is brought into suitable proximity to the nozzle.

Nozzles arranged so that their combined action gives the desired dimension are preferred in many instances. For example, the diameter of a round hole is ordinarily measured with a pneumatic plug gage having two diametrically opposed nozzles (**Fig. 2**). Here the combined clearance to the two nozzles is a direct measure of the diameter of the hole. The gage plug need not be centered exactly within the hole because any decrease in the clearance to one nozzle will be compensated by a corresponding increase in the clearance to the other.

Indicators

Either the flow of the air or its pressure can be measured as an indication of the dimension to be measured.

Fig. 3 shows a rotameter-type and d-p-type flowmeter for measuring the flow of air to the gage plug. A pressure indicator is used for setting the operating pressure of the system at the desired level. The sensitivity of the system can be varied by changing the pressure from the regulator, by passing a portion of the air around the rotameter, or bleeding air from the system at the downstream side of the rotameter.

Fig. 4 shows systems for measuring the pressure.

A restriction can be inserted ahead of the plug. When nozzle clearance increases, the pressure in the line between the restriction and the gage-plug drops. A pressure-sensitive indicator in this line shows the dimension directly. The system can be calibrated by changing the regulated pressure, adjusting the restriction, or bleeding air from the system at the downstream side of the restriction.

The restriction can be replaced by a flow controller which maintains a constant flow in the circuit (Fig. 4B).

Gage Types

Single-nozzle gages (Fig. 5) position the work on a reference surface.

Fig. 6 shows some popular two-nozzle gages. Like all multi-nozzle gages, they must have their nozzles matched so that displacement of the work between them causes negligible changes in reading. Multi-nozzle gages are easier for unskilled operators to use because the work position is not as critical as in single-nozzle gages.

Combination Gages

Some dimensions, such as diameter or length, are obtained as the result of a single measurement. Others require the comparison of two separate dimensions in obtaining the desired value—for example, taper, which is determined by comparing two diameters at different points along the length of the part. Pneumatic gages are readily adaptable to this second classification of measurement because the pressure resulting from the two individual measurements can be combined either by using pneumatic relays or by the direct addition of the flows from several sets of nozzles.

Fig. 7 shows how combinations of dimensions are achieved when measuring the taper of a conical surface—such as the outer race of a tapered roller bearing. Two sets of nozzles measure the diameter at points near each end of the race, and two separate dials indicate these individual diameters. The taper, which is proportional to the difference between the two diameters, is shown on a third indicator which responds to differential pressure.

Fig. 7 also shows the problem of measuring center-to-center distance between two holes, independently of their diameter variations. The solution requires the use of two separate nozzle circuits which are affected in an opposite sense by change of the spacing, but are affected in the same sense by diameter changes. Again, the differential pressure is a measure of the desired dimension, and a differential-pressure indicator could have been used. An alternate method, however, is to convert the differential pressure to a gage pressure in a differential relay, as shown.

Accuracy

The accuracy of pneumatic gaging is a function of the accuracy of the master gages which are used for set-up and calibration. With proper pneumatic engineering, the indicating scales are accurate throughout their length so that master gages for the scale limit points serve for calibration throughout the span of measurement. In normal use, dimensions are measurable to an accuracy of four-millionths of an inch. Accuracy is affected by the smoothness of the surface measured (since the measuring air averages the hills and valleys in a rough surface). For highest accuracy, the work-piece and the calibrating master should have the same surface finish.

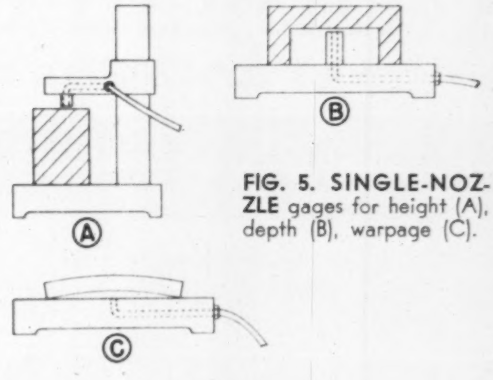

FIG. 5. SINGLE-NOZZLE gages for height (A), depth (B), warpage (C).

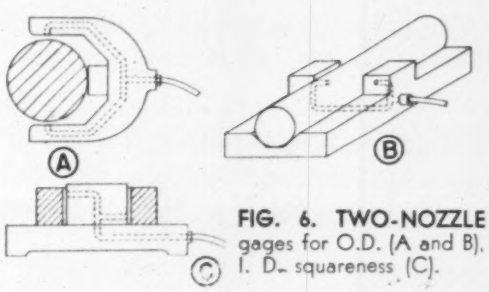

FIG. 6. TWO-NOZZLE gages for O.D. (A and B), I. D. squareness (C).

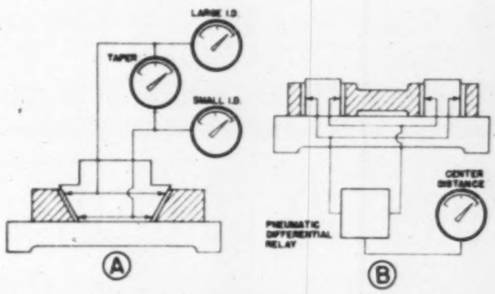

FIG. 7. COMBINATION gages for taper (A) and center distance (B).

COMING IN NOVEMBER:

Dear D. R.*:

I hope this October issue finds you well and happy.

Your November issue will emphasize the subjects of magnetic-tape instrumentation and temperature instrumentation, continuing a series in both of these subjects. The articles in November will include:

1. Survey of Late developments in Tape, Tape Handlers, and Tape Systems.
2. Recording on Tape to 4 Megacycles
3. Updating Magnetic-Tape Records
4. The Triple-Point Cell.
5. Selecting a Thermocouple
6. The Thermion
7. Temperature-Sensitive Paints and Pellets
8. Liquid-in-Glass Thermometers
9. Gas Temperature by Infrared
10. A Hot-Point Seeker
11. Bidirectional counting (Digital Series)
12. Function Generation by DDA (Digital Series)
13. The Simulation Council Newsletter (Analog Feature)
14. Process Control Systems (Process Series)
15. Automatic Pressure Compensation (Process Series)

See you in November
Milt

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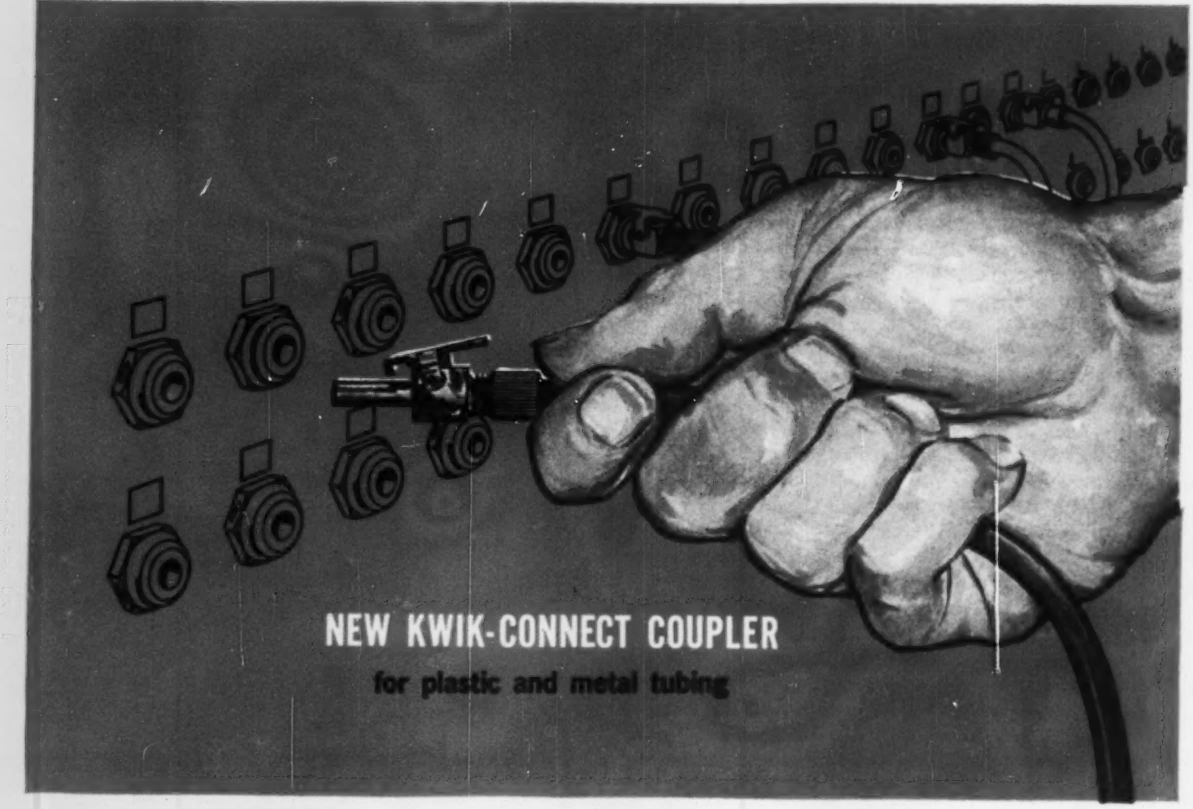
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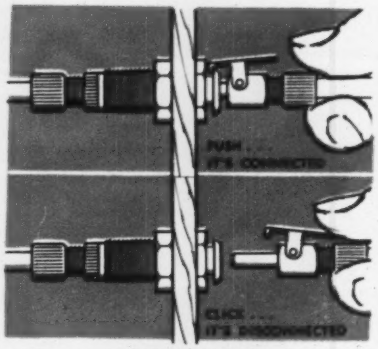

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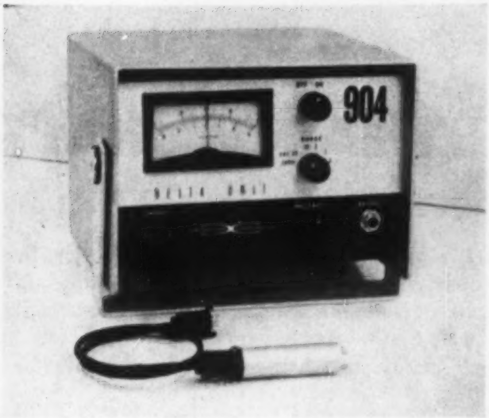


DISPLACEMENT TRANSDUCER

HARRY F. MOORE
The Decker Corporation

THE Delta Unit (Fig. 1) converts minute changes of capacitance resulting from the displacement of a sensor into output voltages. It contains a stable oscillator with its power supply, and the "T-42 Ionization Transducer" with an impedance converter and readout device (Fig. 2).

The oscillator generates a 250-kc high-voltage signal which is applied across the T-42 Transducer by externally attached electrodes. This causes ionization of the gas contained within the transducer envelope. The internal transducer electrodes pick up and deliver a small portion of this high-frequency excitation across the measuring capacitors (C_1 and C_2), which are connected from the internal transducer electrodes to ground. This a-c voltage will vary as the external measuring capacitors are varied. Any a-c voltage difference between the two electrodes gives rise to a d-c potential difference which is much larger than the a-c signal. D-c voltage differences of as much as 30 volts can be obtained without amplification. The T-42 thus converts capacitance variation to a large d-c output voltage signal. Linearity is 1% or better; response is to 15 kc.

In the range of 5-20 $\mu\mu$f initial capacitance, the sensitivity of the Delta Unit to capacitance variation is approximately constant. The one-megohm output impedance of the transducer (each side to ground) requires that the indicator or recording system following the Delta Unit have a high input-impedance. Therefore, a cathode-follower circuit is included in the Delta Unit to convert this impedance to a 1500-ohm output.

Sensor Design

The pickup (purchased or constructed) changes the variable to be measured into a change in capacitance. Physical dimensions of a sensing capacitor can be determined by using the basic capacitor equation of a simple parallel-plate capacitor:

$$C = 0.225\ A/d$$

where C is the capacitance in $\mu\mu$f, A is the area of the ungrounded plate in square inches, and d is the distance between the plates in inches. C should be about 10 $\mu\mu$f for optimum performance.

Once the distance, area, and initial-capacitance parameters are set, the expected open-circuit output signal can be determined. In all cases a differential sensor (Fig. 3) is preferred as the voltage-to-motion or displacement curve will be linear.

Displacements as small as tenths of a microinch can be measured to an accuracy of tenths of a percent, limited only by the stability of the mechanical fixturing. For *pressure measurement,* ranges available are $\pm 0.3''$ H_2O up to $\pm 100''$ (full scale). As resolution is 1 part in 1000, the usable range is $0.0003''$ H_2O to $100''$ H_2O in 6 decades. The gages can indicate *differential-pressure changes* in a 150-psi system in the order of $0.0003''$ H_2O. *Vacuum* can be measured down to 2 microns when one side is provided with a vacuum reference level.

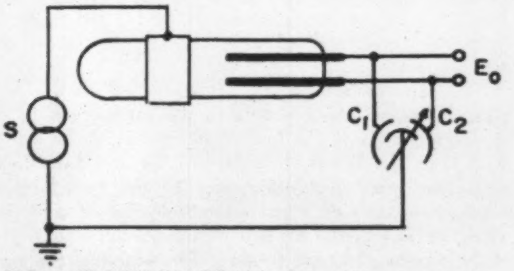


FIG. 2. BLOCK DIAGRAM of sensing components. Differential capacitor varies the ground plate between signal plates from internal electrodes to provide linear d-c voltage output vs motion.

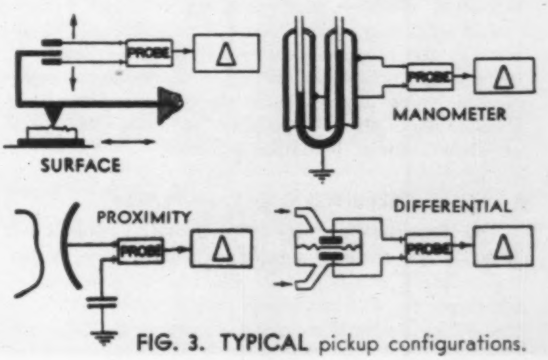
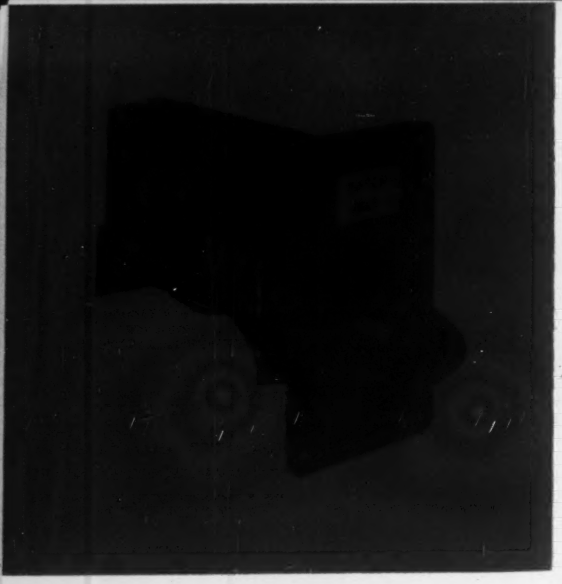


FIG. 3. TYPICAL pickup configurations.



THE LINEAR VARIABLE

The LVDT is a basic displacement-measuring device, featuring simplicity, accuracy and electrical signal output. Application factors include linearity, null voltage, phase angle, sensitivity, excitation, output, cover material, proximity to metals, on-off circuitry and null-balance servo-operation.

WALT W. WINTERS
Vice President
Automatic Timing and Controls, Inc.

A DIFFERENTIAL TRANSFORMER is an electromechanical device for translating the displacement of a magnetic armature into a linear alternating-current voltage.

In any "ideal transformer" (with zero winding resistance, leakage inductances, winding capacitances and core loss, plus infinite winding reactances) the currents in the windings are inversely proportional to the ratio of turns, whereas the voltage ratio is directly proportional to the turns ratio regardless of the load (Fig. 1).

E and H Cores

In the evolutionary development of the differential transformer a number of variants embodying E and H magnetic configurations were devised (Fig. 2). The underlying principle in each was the large variation in the reluctance of the magnetic circuit resulting from relatively small armature movements. These reluctance changes vary the coupling between the primary and secondary windings, thus producing an output voltage.

The sensitivity of the E and H core design is high, but (1) the output is necessarily nonlinear and (2) there is appreciable magnetic pull between the armature and pole pieces. Hence the air-core differential transformer with its negligible "solenoid effect" and excellent linearity of output is better.

Three-Winding Transformer

The three-winding air-core differential transformer (Fig. 3) was the next significant development. A central primary winding and two adjoining secondary windings on an insulating cylindrical bobbin are coupled by a coaxial magnetic armature. The relatively high impedance of this type, a consequence of its geometric arrangement, necessitates a large number of turns to secure adequate flux linkages, which somewhat limits the applicability of this design.

Four-Winding Transformer

The four-winding differential transformer (exclusive ATC development; W. Macgeorge patent 2,568,-587) is the result of considerable design and experimental effort. It has many desirable features—close interwinding coupling, negligible phase shift throughout operating range, low primary and secondary impedance, uniform electrostatic and electromagnetic coupling, excellent stability with temperature and frequency variation, interchangeability of primary and secondary, center tapping facility for bridge applications, and excellent linearity (Fig. 4).

The versatility of the balanced four-coil design is such that not only can the series-aiding primary and series-bucking secondary be interchanged, but the primary coils can be connected parallel-aiding and the secondary coils parallel-bucking, or in other arrangements. Hence mathematical operations such as summation and multiplication present little difficulty with these devices.

In a typical four-winding-type air-core linear differential transformer, the primary and the secondary coils are inter-wound on each of the two sections of the insulating supporting structure (Fig. 4). The primary coils are connected in series-aiding; the secondary series-opposing.

The introduction of an armature within the differential transformer results in the intensification of the flux density in the immediate region of the armature (Fig. 5). When the center of the armature coincides with the electrical center of the transformer, ideally, voltages of equal magnitude but of opposite phase are induced in the two sections of the secondary; the difference voltage is zero. (In practice, the null voltage is a measureable but small quantity.)

The displacement of the armature from the electrical center (null) position results in an increased induced voltage in one secondary coil and a corresponding

DIFFERENTIAL TRANSFORMER

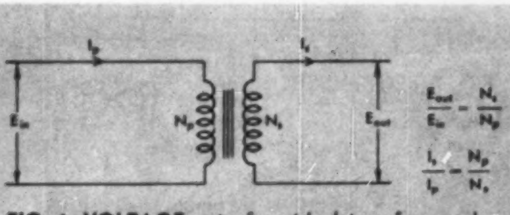

I_p
I_s
E_{in}
N_p
N_s
E_{out}
$\frac{E_{out}}{E_{in}} = \frac{N_s}{N_p}$
$\frac{I_s}{I_p} = \frac{N_p}{N_s}$

FIG. 1. VOLTAGE out of an ideal transformer depends on turns ratio.

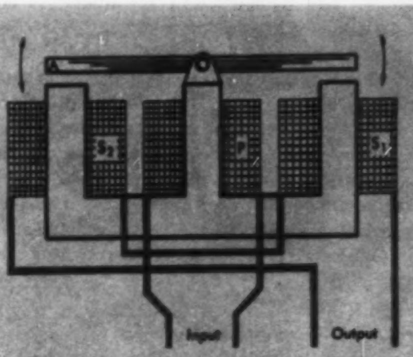


FIG. 2. EARLY E-type core with armature.

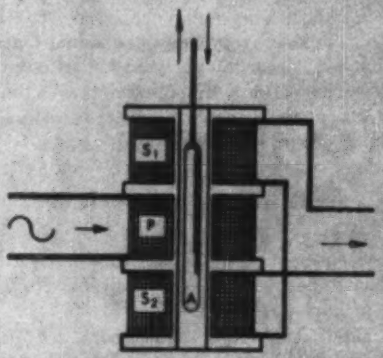


FIG. 3. THREE-WINDING transformer has one primary, two secondary windings. Secondaries are connected series-opposing.

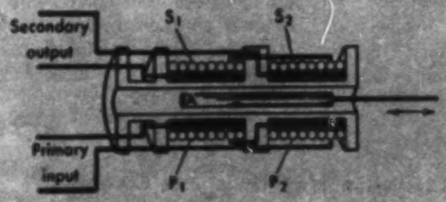


FIG. 4. FOUR-WINDING transformer has two primary and two secondary windings. Secondaries are connected series-opposing.

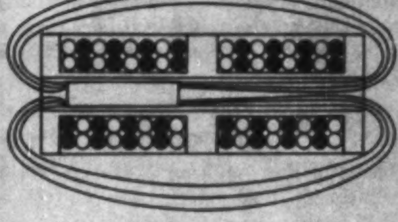


FIG. 5. ARMATURE position determines emf induced in secondaries.

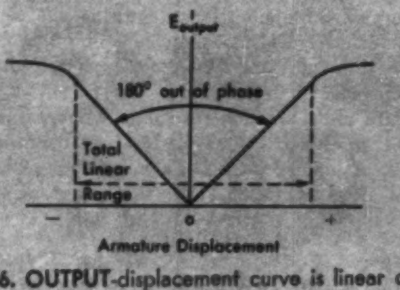


FIG. 6. OUTPUT-displacement curve is linear over operating range.

decreased induced voltage in the other. As a consequence of the 180-degree phase difference existing between the two secondary coils, a differential voltage appears across the secondary terminals. Motion of the armature in opposite directions from null results in output voltages that are 180 degrees out of phase (Fig. 6).

Linearity

The output curve of an actual differential transformer deviates from a straight line. The degree of linearity within a given selected range is defined as the maximum deviation of the actual output curve from the "best fit" straight line passing through the origin, expressed as a percentage of the maximum output voltage. A 6208-A Atcotran, for example, has a linearity of ±0.1% or better for a nominal linear range of ±0.15″ (Fig. 6). In a null-balance system, however, this same differential transformer will exhibit a linearity of ±0.05% or better.

The low output impedance of 22 ohms for a typical transformer permits loading it down to 22 ohms with inappreciable effect on its linearity.

Null Voltage

The null should be as low as possible. That of a typical Atcotran is lower than 0.1 millivolt. The lower the null, the greater the effective output of the transformer and the lower the amplifier residual voltage. This improves the sensitivity, repeatability, and resolution of the servo system.

Phase Angle

In a 4-coil-design differential transformer, the phase angle between the primary and secondary voltages theoretically assumes a value of ±90° at low frequencies (such as 60 cycles), depending on which side of the electrical center the armature is displaced. Actually the distribution may be $-82°$ to $-90°$ and $+98°$ to $+90°$. More significant than the actual magnitude of the phase angle, which can be varied by the insertion of a phase-shift network in the transformer's output circuit, is the inherently negligible phase angle shift over its operating range. Hence servomechanisms require no phase-shift compensation throughout their indicating range.

Sensitivity

The sensitivity of a differential transformer is generally defined as the output voltage per 0.001″ displacement per input volt. Thus the output voltage at a given displacement is equal to the product of the sensitivity, the input voltage, and the number of thousandths of an inch displacement. A typical Atcotran sensitivity is 0.2 mv output/0.001″/volt input at 60 cycles.

Excitation Magnitude and Frequency

The sensing of dynamic displacements requires an excitation frequency that is at least ten times as great at the highest displacement frequency present. The four-coil design can be excited at frequencies up to 20 kilocycles. In applications requiring the sensing of static displacements, a frequency of 60 cycles is adequate, although 400, 1000 and higher excitation frequencies can be used.

Standard units function with input voltages as low as 1 volt or as high as 6 volts without overheating. Variation of input voltage (in a null-balance system) does not affect operation. Thus the use of regulated voltage supplies is not necessary in null-balance systems.

Output Voltage and Wattage

A differential transformer, being a voltage-translating device, necessarily has a low power-output, generally a fraction of a watt. Some types generate sufficient power to actuate an electrical meter or a magnetic amplifier. The output may be rectified if required (Fig. 7).

Characteristic curves for each transformer type depict the relation between output, displacement and frequency. Reference to these will indicate the applicability of a particular transformer to the measurement of a variable such as force, pressure, displacement, velocity, acceleration or temperature.

Quality Factor

A useful index of over-all performance of a differential transformer is its quality factor:

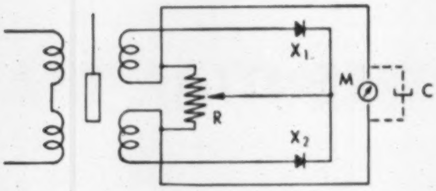


FIG. 7. RECTIFICATION for d-c output signal.

$$\text{Q.F.} = \frac{\text{V out}/0.001''/\text{V input}}{\text{V null}} = \frac{\text{Sensitivity}}{\text{V null}}$$

The null voltage is an unwanted signal that a servo amplifier must discriminate against if its output signal is to drive the servo motor effectively. As the percent harmonic content of the null voltage is generally high, a low null is always desirable.

Input and Output Impedance

The close coupling between primary and secondary in an Atcotran permits the use of comparatively low secondary-impedance. This is desirable from a loading-the-pickup standpoint.

Low input and output impedances, in conjunction with close coupling, permits attaining the necessary flux levels with a nominal 3-volt excitation.

The load impedance must be approximately equal to that of the secondary winding if maximum power transfer is to be secured. If a rectifier is employed, a close approximation to maximum power transfer can be achieved by equalizing the load impedance and the sum of the forward resistance of the rectifier and the secondary impedance.

Cover Materials

To insure against mechanical damage, electrostatic and/or magnetic field interference, LVDT's are encased in either non-magnetic stainless steel or magnetic steel tubing. Operation in an explosive atmosphere or a corrosive medium requires a completely sealed stainless-steel enclosure. Operation in variable or high-intensity magnetic fields requires a magnetic steel shell with annular steel end pieces.

Differential transformers encased in stainless steel should be isolated from extraneous fields, and a limit should be placed on the proximity of two or more transformers to avoid mutual interaction. Arranging a number of transformers parallel to one another with alternate ones reversed (end for end) tends to cancel interacting fields.

A unit encased in magnetic steel is reasonably independent of external fields and the proximity of metallic masses. It will also exhibit (1) increased sensitivity, output voltage, and power, (2) reduction in the transformer's stray magnetic field, and (3) reduction of voltages induced by external fields.

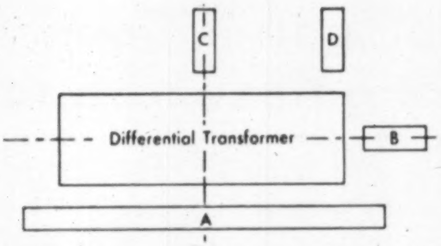


FIG. 8. LOCATION of metallic masses near transformer affects linearity and sensitivity.

Proximity of Metals

Regardless of the enclosing material, some of the magnetic field will be distributed in the region surrounding it. The introduction of any metallic mass in this field will distort the normal pattern, with degradation of linearity, null voltage increase, and phase-angle variation. Nonferrous masses will have induced eddy currents, which generate an oppositional magnetic flux, also distorting the existing field.

Fig. 8 indicates a differential transformer with rectangular metallic masses located in different positions—A, B, C and D. Assuming these masses to be of the same material the following can be stated:

(a) Mass A causes least phase shift effect. It tends to depress the null and sensitivity and only slightly affects linearity.

(b) Mass D produces phase shift and an asymmetric displacement-output curve.

(c) Mass B has an even more pronounced although similar effect to D because the flux concentration is higher at B.

(d) Mass C has little or no effect because its symmetric location affects each section of the transformer equally.

The intensity of the proximity effect is proportional to the masses in each position and also to the material in the following descending orders—iron, aluminum, brass, and stainless steel.

Fluctuation of Input Voltage and Frequency

Fluctuation of the input voltage of a differential transformer is reflected in a corresponding proportional fluctuation of its output voltage—unless a null-balance system is used. A voltage-regulating transformer should be used in the former case.

In a null-balance system, two similar differential transformers are the circuit elements (Fig. 9). As the primary windings are excited series aiding, independence of line voltage fluctuation is attained.

The same considerations that apply to the fluctuation of input voltage hold with regard to input frequency fluctuation. If, however, the fluctuation is excessive, other elements in the null-balance circuit, such as the detector, may be affected adversely. Normal variations in power-line frequency do not interfere with proper functioning of the servo system. In general, change in frequency results in even smaller percent changes in sensitivity than does change in input voltage.

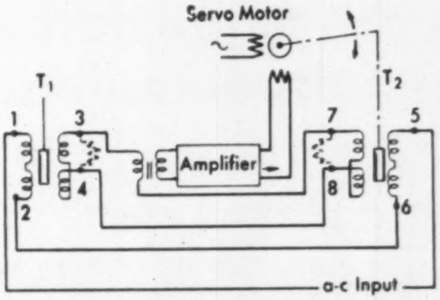


FIG. 9. NULL-BALANCE system uses two LVDT's.

Special Designs

Ratio Windings

Specific applications for a differential transformer may require an array of design parameters not attainable by the standard interwinding method, which has a secondary-to-primary turns ratio of unity. The use of separate windings considerably extends the possible number of winding configurations. Typical arrangements of separate primary and secondary windings include (a) secondary-to-primary turns ratios exceeding unity for increased sensitivity, (b) windings of different gauge or even different composition to achieve various input and output impedance to specification, range extension, phase shift, and desirable temperature characteristics, (c) bottom wound secondary and overlapping primary for maximum sensitivity, and many others.

Dual Secondary

Although the basic 4-coil design is useful for most applications, the following variations are available, all with a series-aiding primary winding: (a) two separate secondary windings—a series bucking and a center-tapped series-aiding winding; (2) two separate secondary windings, one of which has a primary-secondary turns ratio of unity whereas the other has a turns ratio that generates one tenth the voltage output of the former; (3) two identical series-bucking secondaries; (4) two identical center-tapped series-aiding secondaries; others.

Proximity Type

A differential transformer can be adapted to the function of sensing the presence of ferro-magnetic masses, thereby becoming a "proximity coil." For various reasons it has proven practicable to mechanically separate the two electrically connected components of a proximity coil (reference coil and sensing coil) as shown in Fig. 10.

The reference coil is equipped with a co-axially mounted iron screw which permits the introduction of a variable amount of distortion in its flux pattern. This coil may be located remotely in a cabinet or panel with relays and associated control equipment. The other half of the proximity coil (the sensing coil) is located so that the presence or absence of a mass of metal, irregularities of gear teeth, variation in metal

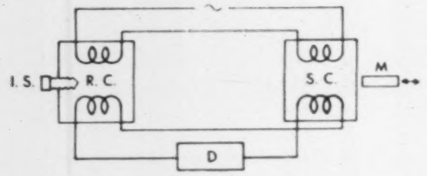


FIG. 10. PROXIMITY system. Detector (D) is meter or relay; R. C. is reference coil; S. C. is sensing coil; I. S. is iron-adjusting screw.

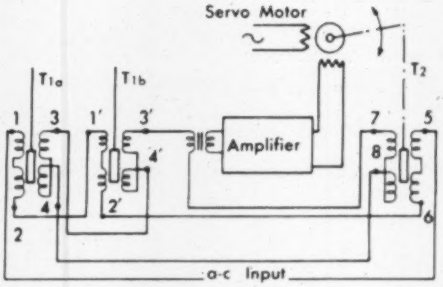


FIG. 11. SUMMATION circuit has all primaries and all secondaries in series.

thickness, etc., can be detected. The combination of proximity coil and control relay constitutes a contactless switch that is ideal for many machine operations.

Applications

Although differential-transformer applications are numerous, all use one or the other of two basic circuits. One is an *on-off circuit,* the other is a *null-balance circuit.* Variations of these two basic circuits provide great flexibility.

The on-off electronic switch is simply a differential transformer and amplifier-relay. The relay operates when the LVDT output reaches a predetermined value. A second differential transformer may be incorporated in the circuit as a zero set. The on-off circuit can have a repeat accuracy as high as 0.0001″. For go-and-no-go gaging, and other operations which call for range actuation rather than point actuation, the circuit is basically the same. Sequence or "serial" operation of control points from a common sensing differential transformer-transmitter can be accomplished by means of relays or switches.

Null Balance Circuit

The null-balance system (Fig. 9) employs two or more differential transformers in a bridge circuit. When the system is balanced, there is no resultant action. When an unbalance occurs, due to displacement of the armature of the sensing differential transformer, the system acts in a proper direction and the proper amount to restore balance. Variations of this circuit include algebraic summation and multiplication circuits.

Algebraic Summation Circuits

The outputs of more than one differential transformer can be added simply by connecting all primaries in series and all secondaries also in series, as shown in Fig. 11.

Multiplication Circuits

The outputs of two or more differential transformers can be multiplied to provide a signal proportional to their product. This is done by having the output of one differential transformer drive another as shown in Fig. 12.

The LVDT has became a popular device for measuring displacement in gaging, calipering, tension control, edge-guide control, flowmetering (where it measures displacement of a rotameter or transmitter element), pressure or differential pressure (where it measures the displacement of a bourdon or diaphragm), force, viscosity, specific gravity, etc. Fig. 13 shows its use in load measurement.

Typical displacement-sensing accuracy in a 60-cps system is 3 microns. Even smaller motions can be detected by using higher-frequency excitation or higher-gain amplifiers.

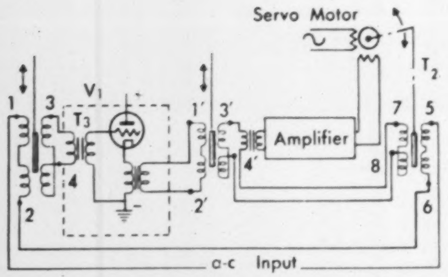


FIG. 12. MULTIPLICATION circuit uses output of first LVDT to excite second LVDT.

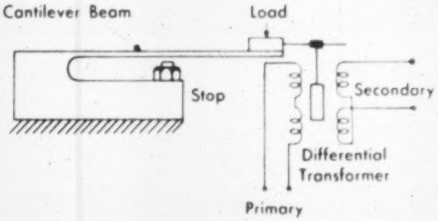
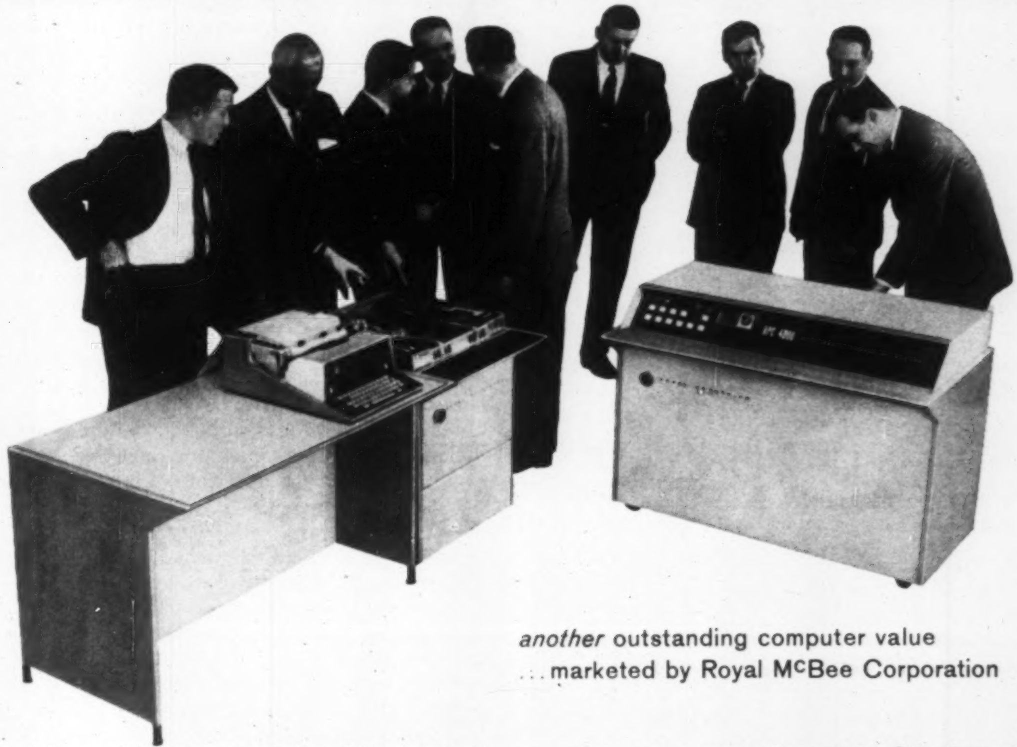


FIG. 13. LVDT used to measure load.

For engineering, for research, for business data processing in companies both large and small . . . **The new, fully-transistorized**

RPC-4000

ELECTRONIC COMPUTING SYSTEM



another outstanding computer value
. . . marketed by Royal McBee Corporation

Advanced design: fully transistorized—with important new computer design concepts that provide the largest memory, greatest problem-solving capacity and flexibility in the low- or medium-priced field. Entire system —computer, input-output typewriter and tape punch-read console—have been specially designed as a unit. **High-speed computing ability:** extra large capacity (8008 words) magnetic drum memory, with special fast access features. Computing speeds of up to 230,000 operations per minute. **Ultra high speed input-output:** 500 characters per second photoelectric punched paper tape reader, and 300 characters per second paper tape punch available as optional equipment. **Easy to use:** maximum results can be obtained by non-technical personnel. Users benefit from free training, continuing assistance, an extensive library of programs. Versatile command structure provides programming speed and flexibility. **Low in cost:** priced just above the small-scale computers, the RPC-4000 outperforms computers costing many times more. **Economical to install and operate:** no site preparation, air-conditioning or special maintenance required. Plugs into any standard wall outlet. **Multiple application ability:** designed to perform engineering, scientific and research calculations, as well as business data processing and management control functions.

The RPC-4000 is a product of the Royal Precision Corporation, and is marketed by the Data Processing Division of Royal McBee. It is the latest member of the growing family of electronic computers from the people whose LGP-30 has become the world's leading small-scale computer.

Royal Precision Corporation

Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. RPC-4000 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing offices. For full specifications, write ROYAL McBEE CORPORATION, data processing division, Port Chester, N.Y.

CIRCLE 69 ON READER-SERVICE CARD

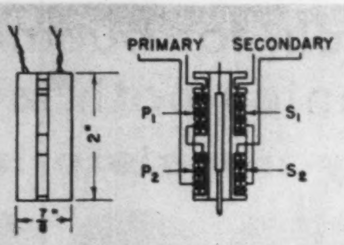

PRIMARY
SECONDARY
P_1
P_2
S_1
S_2
2"
7/8"

FIG. 1. STRUCTURE of the LVDT.

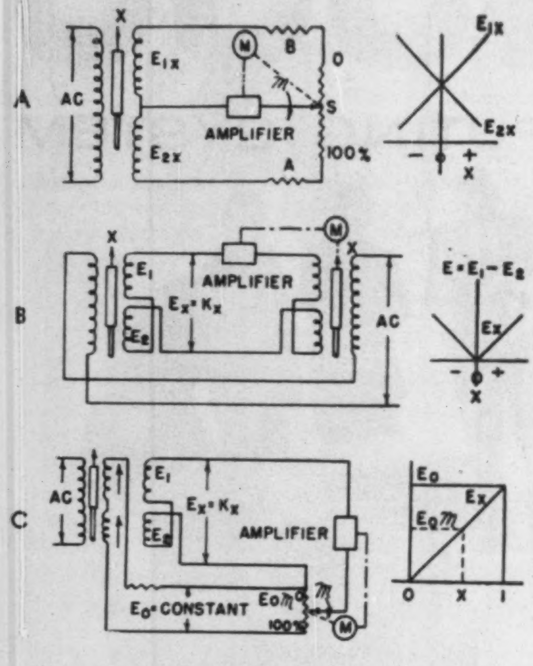

A
AC
X
E_{1X}
E_{2X}
M
B
O
S
AMPLIFIER
100%
A
E_{1X}
E_{2X}
− 0 +
X
B
X
E_1
E_2
AMPLIFIER
$E_X = K_X$
M
AC
$E = E_1 - E_2$
E_X
C
AC
E_1
E_2
$E_X = K_X$
AMPLIFIER
E_0 = CONSTANT
100%
M
E_0
E_X
O
X
I

FIG. 2. BASIC MEASURING circuits comprise (A) resistance ratio balance, (B) potentiometer-coil balance, (C) potentiometer-slidewire balance.

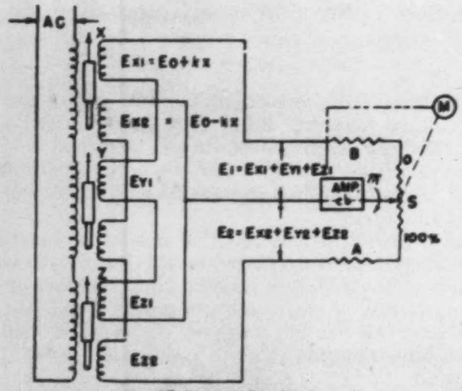

AC
X
$E_{X1} = E_0 + kx$
$E_{X2} = E_0 - kx$
Y
E_{Y1}
Z
E_{Z1}
E_{Z2}
M
B
O
S
100%
A
AMP.
e_b
$E_1 = E_{X1} + E_{Y1} + E_{Z1}$
$E_2 = E_{X2} + E_{Y2} + E_{Z2}$
AT BALANCE, $e_b = 0$
$\frac{E_1}{E_2} = \frac{E_{X1}+E_{Y1}+E_{Z1}}{E_{X2}+E_{Y2}+E_{Z2}} = \frac{B+\mathcal{M}S}{A+S-\mathcal{M}S}$
$\mathcal{M} = \frac{x+y+z}{3}$

FIG. 3. TOTALIZING slidewire balance.

THE LVDT IN

THE ADJUSTABLE-CORE TRANSFORMER is used extensively in measuring position or motion. The magnetic core of the transformer is moved mechanically, producing an a-c signal. Figs. 1 and 2 show the structure and principle of operation. The magnetic flux linkage between the primary winding and each of the two secondaries is determined by the magnetic core position. Consequently the voltages induced in the secondary windings vary linearly and differentially in opposite directions.

Fig. 2 shows basic self-balancing measuring circuits.

In the *ratio-balance circuit* (Fig. 2A) the secondaries are connected so that their voltages add. At balance the fundamental voltage input to the amplifier is a minimum, and the angular position of the follow-up slidewire indicates the position of the transmitter core and consequently the measured variable.

In the *potentiometric circuit* (Fig. 2B) the secondary windings of the transmitter are connected in phase opposition so that the total voltage is a proportional function of the core position. An identical transformer unit in the receiver is positioned by the motor and the system is balanced when the transmitter and the receiver core positions are exactly the same.

This system has several advantages over the one shown in Fig. 2A—the most important is that no current flows in the leads of the measuring circuit. Consequently, it can be used over greater distances without being affected by line resistance.

In the *slidewire-balance* type of potentiometer system (Fig. 2C), two pairs of secondary windings are used on the transmitter. The pair with the opposing-connected secondary windings sets up a voltage proportional to the transmitter core position. The other pair of windings (connected with the voltages adding) sets up a reference potential for the balancing slidewire. The system is calibrated by adjusting the voltage across this slidewire with the series resistance so that E_o is equal to the maximum output of the transmitter.

This type of pickup is particularly adaptable to the telemetering of flow and differential pressures, where the moving element of the basic meter device (including the transformer core) can be enclosed entirely in a high-pressure chamber.

The transformer also can be used as a retransmitting element in recording meters. This is particularly advantageous where the output of the retransmitter must be a nonlinear function of the measured variable. In

MOTION MEASUREMENT

A. J. HORNFECK
Bailey Meter Co.

a complex process computing system, many of these retransmitter converters might be used to order to translate the various metered functions, such as pressure, temperature, and flow into electrical quantities.

Basic Computing Circuits

Figs. 3 to 7 show circuits using the transformer transmitter for the simple arithmetic functions of addition, subtraction, and division of transmitted variables.

Addition

In Fig. 3 the per-unit rotation of the motor-driven balancing slidewire is equal to average motion of all the transmitter cores.

The lower or zero-end windings all are connected in series adding. Similarly, all the top windings are connected in series adding.

The cores are centered at ½ of maximum stroke and the fixed resistors A and B are adjusted equal. The slidewidewire rotation M is then the sum of the individual motions of the transmitter cores divided by the number of transmitters. For example, in Fig. 3 there are three variables—X, Y, and Z. Consequently: $M = (X + Y + Z)/3$

If the ranges of the transmitters are not equal, the strokes of the cores can be adjusted proportionally.

Another addition circuit is shown in Fig. 4. The balancing is performed by a differential transformer unit. The voltage output of each transmitter is adjusted by potential-dividing resistors to provide equal full-scale range. At balance:

$$M = X + Y + Z$$

Subtraction

In subtracting circuits (Fig. 5) the transmitter secondary windings are connected in phase opposition to produce voltages proportional to each transmitter variable.

Subtraction is accomplished by connecting the opposed secondary windings in series. The difference between the totals of two groups of variables can be accomplished by substituting the total voltage for E_x or E_y.

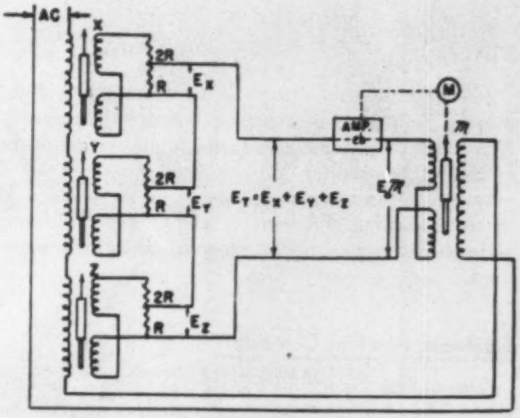


FIG. 4. **TOTALIZING** transformer balance.

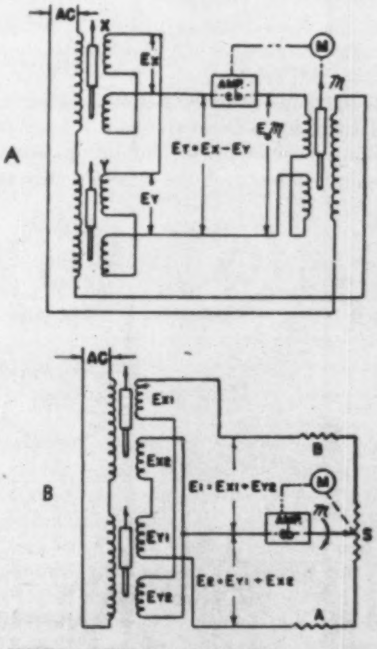


FIG. 5. **SUBTRACTING** via transformer balance (A) or slidewire balance (B).

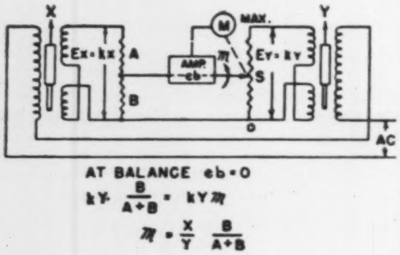

X
Y
MAX.
M
Ex = kx
A
B
AMP.
-eb-
Ey = ky
S
0
AC
AT BALANCE eb = 0
kY · B/(A+B) = kY M
M = X/Y · B/(A+B)

FIG. 6. **RATIO CIRCUIT,** slidewire balance.

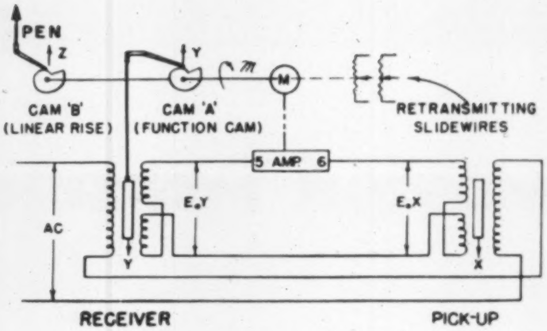

PEN
Z
Y
M
CAM 'B'
(LINEAR RISE)
CAM 'A'
(FUNCTION CAM)
RETRANSMITTING
SLIDEWIRES
5 AMP. 6
AC
E₀Y
E₀X
Y
X
RECEIVER
PICK-UP

FIG. 7. **NONLINEAR** function computer.

Ratio

In the ratio computing circuit (Fig. 6), a fixed proportion of the linear voltage output of transmitter X is compared against an adjustable proportion of the output of transmitter Y. The proportion of the Y output required to balance depends on the position M of the balancing slidewire. A and B are calibrating resistors determined by the range of ratios to be measured.

Nonlinear Function Computer

The system shown in Fig. 7 has proved to be a powerful tool in metering single variables or combinations of process functions where the transmitter motion is a nonlinear function of the measured variable, and the measured variable is to be converted into another function for computing purposes. The relation between the balancing-core motion Y and the servomotor shaft rotation M depends on the shape of the Y cam: $M = f(Y)$.

Since the motor shaft rotates in accordance with the desired function, a linear-rise cam is used to actuate the linkage positioning the indicating, recording, or integrating elements of the receiver. Retransmitting slidewires actuated by the same motor reproduce the desired function as linear voltage or resistance for control, computation, or further telemetering.

This system is used frequently to convert a measurement of differential pressure to fluid flow for linear recording. In other applications this system is used to convert a measured variable (such as temperature) to some nonlinear function of this variable (such as the specific heat of a heat transfer fluid).

The cam-operated transformer balancer is generally superior to the tapered-slidewire followup for the conversion of functions because cams can be cut to a greater degree of accuracy. Slidewires can be wound to the desired functions but the range of taper of slidewires is relatively limited, whereas the cam rise rate can be made to cover a range from zero to almost infinity.

An application of the function generation technique is shown in Fig. 8, the use of LVDT's for obtaining a compensated flowmetering signal.

$$W = K\sqrt{hP}/T$$

where h is the head, or differential pressure, measured by an inferential flowmeter, P is pressure of the flowing fluid and T is temperature of the flowing fluid.

Abstracted in part from AIEE paper 52-191.

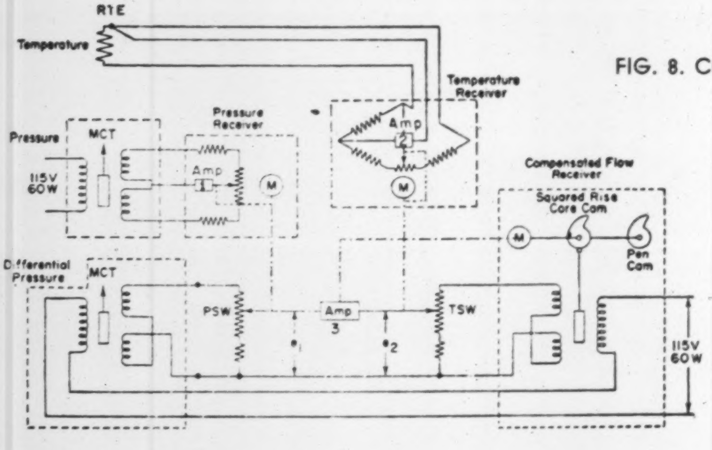

R1E
Temperature
Temperature
Receiver
Pressure
Receiver
Pressure
MCT
115V
60W
Amp
M
Amp
2
M
Compensated Flow
Receiver
Squared Rise
Core Cam
M
Pen
Cam
Differential
Pressure
MCT
PSW
Amp
3
TSW
e₁
e₂
115V
60W

FIG. 8. **COMPENSATED** gas flowmeter.

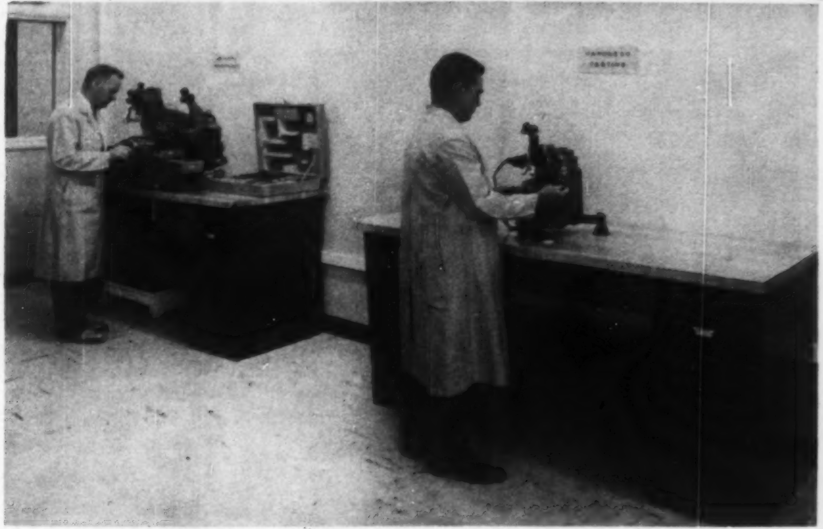


FIG. 1. **KEARFOTT'S MECHANICAL METROLOGY LAB.** Specimen at right is being tested for hardness on a Kentrall Micro-Hardness tester. Diameter of master taper ring is being checked at left on the Universal measuring machine.

Kearfott's Metrology Department

Here are the facilities, procedures, equipment capabilities of an exprienced mechanical metrology department.

J. FLYNN
Kearfott Div.
General Precision, Inc.

TODAY'S TECHNOLOGY demands ultimate accuracy in all phases of fabrication; design concepts often are based on tolerances specified in millionths of an inch.

Kearfott Division, General Precision, Inc. (for 15 years a major source of precise components and systems for missiles, aircraft, submarines, industrial controls, etc.) provides facilities for an in-plant "bureau of standards" by means of a *Metrology Department*, which contains the tools, gages, and environmentally controlled areas necessary to implement a highly effective system of measurements.

Metrology Department

The Metrology Department, part of Kearfott's Quality Control Branch, is responsible for the control of inspection tools and gages, electronic standards, calibration, certification, and preventive maintenance measures. Functioning within this department are the *Electronic Metrology Section* and the *Mechanical Metrology Section*. Each section is staffed by experienced and skilled engineering and technical personnel who work under the direction of the Chief Metrology Engineer.

The *Mechanical Metrology Section* is responsible for approval of all gage designs, the gage inspection crib, preparation and coordination of quality standards, gage control, engineering assistance in the design of gages, improving gaging methods and techniques, establishing inspection cycles and controlling the operations of the Mechanical Metrology Lab.

(The *Electronic Metrology Section* performs Master Reference surveillance, inspection, and calibration of test equipment for electrical characteristics as well as time, frequency, angular measurement, temperature,

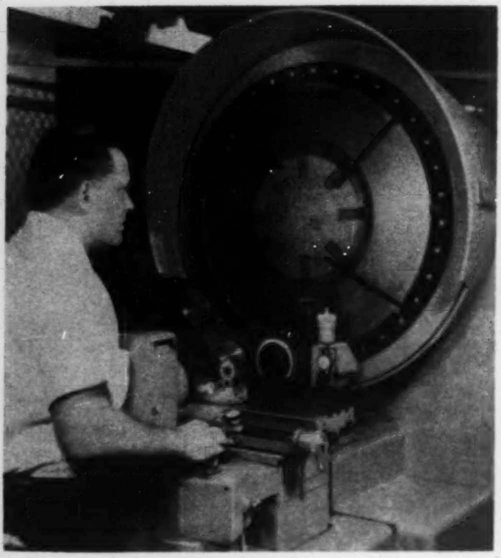


FIG. 2. OPERATOR CHECKS stator insulator on 30" Contour Projector, with comparator chart.

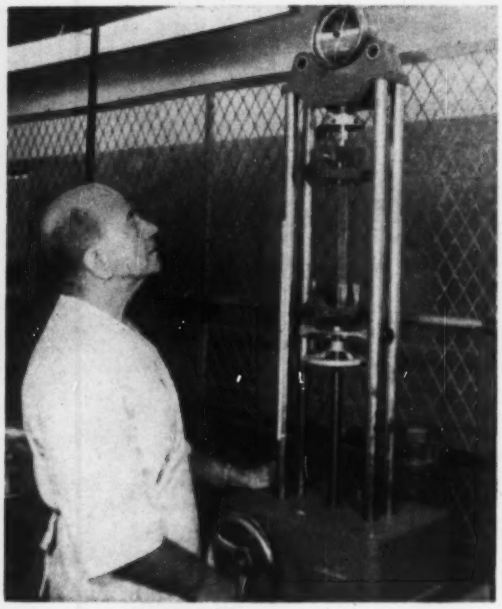
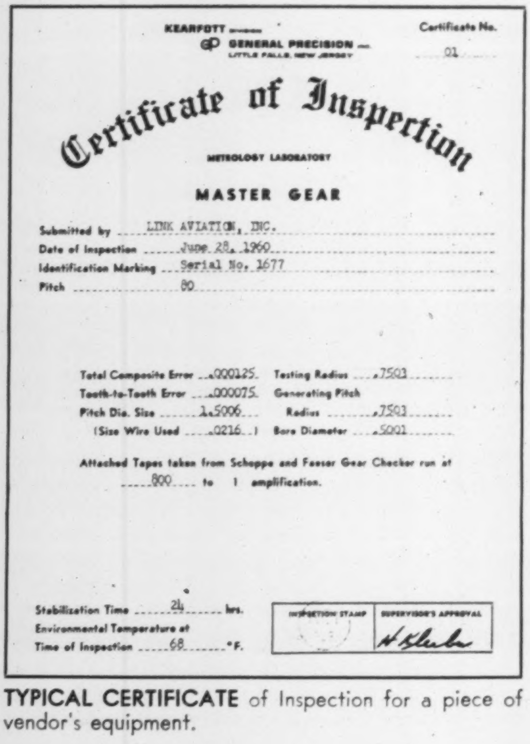


FIG. 3. CHECKING ADHESIVE characteristics of araldite with a tensile test machine.

pressure, and vacuum. In addition, this section supervises the activities of the Electronic Metrology Lab.)

All standards in the Metrology Department are regularly submitted for certification to the National Bureau of Standards, or to other primary level agencies which, in turn, submit them to the National Bureau. To provide maximum certainty that certified values remain in tolerance, cross references between standards are performed constantly.



KEARFOTT DIVISION
GP GENERAL PRECISION INC.
LITTLE FALLS, NEW JERSEY

Certificate No. 01

Certificate of Inspection

METROLOGY LABORATORY

MASTER GEAR

Submitted by LINK AVIATION, INC.
Date of Inspection June 28, 1960
Identification Marking Serial No. 1677
Pitch 80

Total Composite Error .000125
Testing Radius .7503
Tooth-to-Tooth Error .000075
Generating Pitch Radius .7503
Pitch Dia. Size 1.5006
(Size Wire Used .0216)
Bore Diameter .5001

Attached Tapes taken from Schoppe and Faeser Gear Checker run at 800 to 1 amplification.

Stabilization Time 24 hrs.
Environmental Temperature at Time of Inspection 68 °F.

INSPECTION STAMP | SUPERVISOR'S APPROVAL

TYPICAL CERTIFICATE of Inspection for a piece of vendor's equipment.

As part of its function, the Metrology Department issues standard practices for electrical inspection and supplementary technical information regarding equipment designation and use. To improve inspection efficiency, visual inspection standards (actual piece samples) are mounted and identified both for training purposes and for use as cross references.

Facilities and Procedures

Each laboratory encompasses an area of 1000 square feet in specially designed rooms isolated from the rest of the building. All measurements and calibrations are performed on special work tables under stringent environmental conditions of temperature and humidity: temperature is maintained at 68°F ±1° in the Mechanical Laboratory (72°F ±1.5° in the Electronic Laboratory); relative humidity in both laboratories remains constant at less than 50%. Carefully designed lighting conditions provide shadowless and glare-free illumination; an acoustical ceiling minimizes noise. Access to the laboratories can be achieved only through an air lock, and all personnel are required to wear nylon smocks. No unauthorized personnel are permitted entrance.

Working standards received in the laboratory are allowed to become temperature stabilized before calibration is performed. Calibration scheduling, maintenance of records, etc., are performed outside the laboratories to permit maximum utilization of laboratory space for measurement purposes.

Since calibration examinations in excess of 15,000 per year are performed by the laboratories, punched-

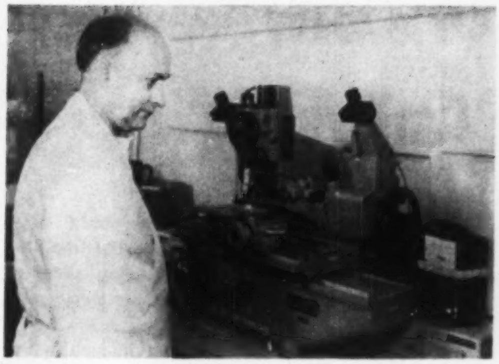


FIG. 4. USING THE Universal Measuring Machine, with electronic indicator attachment, to check hole locations in a gear plate.

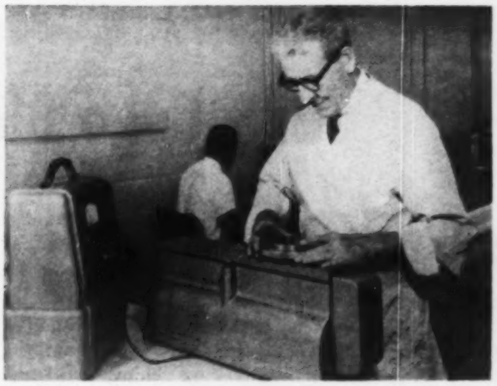


FIG. 5. USING THE Internal Electronic Comparator to measure inside diameter of a ring gage.

card systems are used to assure an orderly and accurate record of calibrated equipment and an even distribution of work load.

Certification of Vendors' Equipment

The Metrology laboratories also provide measurements and certification of standards, gages, and masters for vendors and subcontractors to extend the area of control and thereby preclude incorrect usage of equipment. This service is performed at a nominal cost and the equipment certified is recorded by a Certificate of Inspection. In addition, this service reduces the amount of rejection because vendors' gaging is maintained on a comparable level with Kearfott gaging.

Equipment Capabilities

It is standard practice to use tools which are ten times more accurate than the parts measured. Since many of the parts incorporated into Kearfott components are characterized by exceedingly minute tolerances, the metrology equipment used must be extremely precise. A representative inventory of mechanical equipment capability includes:

INSTRUMENT	ACCURACY
Universal Measuring Machine (S.I.P.)	0.00001" (10 μin)
External Electrolimit Comparator (P & W)	0.00002" (20 μin)
Internal Electrolimit Comparator (P & W)	0.00002" (20 μin)
Internal Comparator (Sheffield)	0.00001" (10 μin)
Universal Internal Electrolimit Comparator (P & W)	0.00002" (20 μin)
Standard Measuring Machine (P & W)	0.00001" (10 μin)
Indi-AC Electronic Indicator (Cleveland)	0.00001" (10 μin)
Accutron Electronic Height Indicator (Sheffield)	0.00001 inch (10 μin)
Hardness Tester (Kentrall)	Knoop Scale
Master Reference Gears for use with S & F Gear Checker	0.00005 inch (50 μin) composite error
Supermicrometer (P & W)	0.00010 inch (100 μin)
Kodak Model 30 Contour Projector	Micrometers—0.0005" over their 1" range; Viewing screen (30" wide) graduated to 2 minutes of arc.
Dillon Tensile Tester	2%

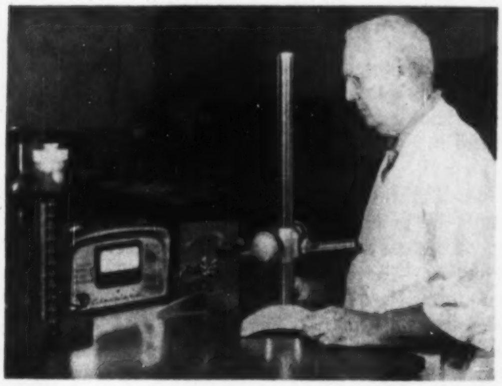


FIG. 6. USE OF Cleveland electronic height gage and indicator.

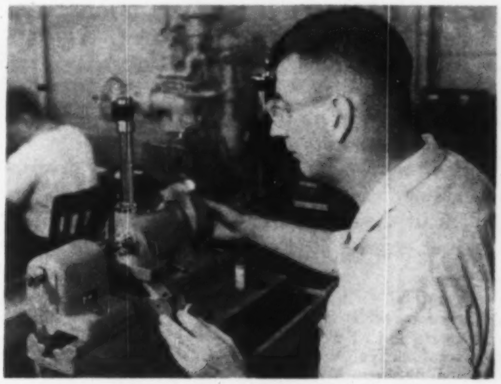


FIG. 7. PRATT & WHITNEY Electro-limit comparator for measuring outside diameter.

NBS Gage Block Calibration

MASTER END STANDARDS, or gage blocks, are calibrated by the National Bureau of Standards for other government agencies and for industrial and scientific laboratories. By this means the Bureau extends its length standards throughout the country and makes it possible for industry to produce, in different factories, precision parts which are interchangeable.

The Bureau annually calibrates over 4,500 end standards. This large workload has made it profitable to investigate the applications of semi-automatic methods of calibration. A large portion of these calibrations are made by mechanical comparison with master end standards rather than by measurement by the use of lightwaves. For the calibration by comparison procedure, the observer records the original observations on punched cards. After this has been done, automatic programmed computing equipment applies all corrections and ultimately types out the report. This not only accelerates the work but eliminates many sources of error and much tedious checking.

Periodically, the original punched cards prepared by the observer are subjected to a different program by the computing machine, which tests the consistency of the results obtained by the comparison of a given gage submitted for test with the different Bureau master gages. This affords a check on the correctness of the calibrations of the Bureau gages with a minimum of additional work. An extension of a similar method to the gages that are measured directly in terms of lightwaves is planned.

The National Bureau of Standards has a research program on high-precision gage blocks, partially supported by industry*. This program seeks regular methods for calibrating industry's master gage blocks to an accuracy of 1 part in 10 million. These gage blocks, which ultimately control the tolerances of mass-produced machine parts, are now calibrated at the Bureau to an accuracy of 1 part in 1 million—that is, to the nearest millionth of an inch for inch-long blocks. However, American machine tool manufacturers have requested an even higher degree of accuracy in gage-block calibration in order to keep pace with the needs of the aircraft and other industries.

In 1958 emphasis was shifted from the development of improved measuring instruments to the application of these instruments to the development of more precise gage blocks. Studies were made of the suitability of different steels for constructing the blocks. Optimum conditions were also established for heat-treating and stabilizing several of the steels commonly used for gage blocks.

An ideal gage would be unchanging in length, but almost any material will gradually grow or shrink with time. To detect the small changes that occur in a relatively short period a method was developed by which comparisons accurate to approximately 1 part in 10,000,000 are achieved. This method, providing measurements 10 times more precise than any previously attained, is being used to study the relative desirability of various steels for gage construction, and to determine the coefficients of thermal expansions.

In the study of materials suitable for use in the production of ultraprecise gage blocks, optimum conditions were established for heat treating and stabilizing several steels commonly used both for gage blocks, and for nitriding types 410 and 302 stainless steels and Nitralloy. Other procedures for producing hard surfaces on gage blocks, such as flame and chromium plating, thermospray, chromizing, carbonitriding, and carburizing have been evaluated. Additional material selected and procured for use in the program include alumina, titanium carbide precipitation-hardening stainless, and high-speed tool steel.

In one phase of the program a design was completed for a new interferometer to measure lengths in terms of a wavelength of light to a part in 10 million. An extensive study was undertaken of phase change of light in reflection. This change is a source of error in interferometric length measurement, necessitating corrections.

By applying atomic beam techniques, extremely monochromatic optical radiations ($\lambda =$ 2537A) were produced. The bandwidths of these radiations are one-fourth as wide as the narrowest lines conventionally produced. Thus interference can be observed over a path length exceeding 2 meters with a precision of 1 part in 10^9.

An emission beam source utilizing natural mercury has also been tested and found satisfactory within the limits imposed by natural mercury. A revised version of this source will be filled with isotopic mercury and tested.

Another atomic beam device that has given good results in preliminary tests employs the absorption line of mercury of 2537A. The device serves as a detector, sensitive to radiations over only a very narrow band or curve. The wavelength of this narrow and precisely defined sensitivity curve can be used as a definition of the meter. A third instrument developed utilizes a properly balanced Michelson interferometer. The device produces an emission line from an absorption process in an atomic beam of mercury.

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*The group of manufacturers working in cooperation with the Bureau are the Dearborn Gage Co., DoAll Co., E. I. duPont de Nemours & Co., Fonda Gage Co., Inc., General Electric Co., Greenfield Tap & Die Corp., Hughes Aircraft Co., International Business Machine Corp., Link Aviation, Inc., New Departure (General Motors), Pratt & Whitney Co., The Sheffield Corp., Taft-Pierce Foundation, Timken Roller Bearing Co., and the Van Keuren Co.

WHAT TO LOOK FOR IN ELECTRONIC CONTROL SYSTEMS

Ever since the introduction of the first electric control system, comparisons between pneumatic and electric systems have been common and numerous. However, the recent introduction of several new electric control systems makes pertinent a discussion of how to compare electric control systems.

WALTER S. SHARSHON
Brown Instruments Div.
Minneapolis-Honeywell Regulator Co.

THE PRESENT INTEREST in electric control systems stems from the need for operational characteristics not available with pneumatic systems —increased response speeds, greater transmission distance, and reliable all-weather operation.

The initial cost of instrument units does not indicate total system installation cost, nor does it indicate long-term operational costs. An optimum instrument installation has the fewest possible number of instruments to install, a minimum number of transmission wires to connect, the simplest power supply system to provide power, and flexibility in mounting.

Minimum Interconnection Wires

A minimum number of transmission wires will substantially decrease installation costs. A two-wire transmission system is the practical minimum and should function properly without expensive restrictions on wire type, gage, or shielding.

Power Supply Requirements

Every electric system requires a source of power —but the complexity of the power supply and where power is applied are important considerations. It is expensive, inconvenient, and frequently impractical to provide power at each and every transmission point.

An electrical system that does not require external power at the transmittal point and still maintains a single unit for a single function with simple 2-wire transmission has greatest flexibility. An ideal arrangement will permit tie-in of the power source at any point in the control loop. Usually, however, electric power will be available at some central control point or where the receiver is located.

Type of Transmission Signal

Both direct-current signals and alternating-current signals are used in presently available electric systems. A direct-current transmission signal is least susceptible to stray pick-up, which may be not only difficult to find but costly to filter out. Direct-current transmission is directly adaptable to data logging and analog computers, and is suitable for long distance transmission (it should be possible to transmit signals for several miles with a normal loop configuration of a recorder, controller and alarm units). Alternating-current transmission, however, permits lower cost transmitters.

Modular Design and Common Signal

Separate transmitting, receiving, and control units are in keeping with modern schemes. These modular building-block elements permit the greatest ease and flexibility in the addition or subtraction of functions within the loop, where and when required. Such functions as alarms and additional indication or recording can be added as necessary.

A single transmission signal range interconnecting process-mounted and control-room-mounted instruments permits optimum use of the building-block approach. The same receiving and controlling instruments can be used with any process variable transmitter.

CHECK LIST

	Yes	No
1. Minimum number of transmission wires	____	____
2. No shielded or special wire in transmission line	____	____
3. No separate power tie-in at transmitters	____	____
4. Plug-in or quick-connect assemblies for maintenance ease and minimum down-time	____	____
5. Components and sub-assemblies interchangeable between instruments	____	____
6. All components easily accessible for checking and replacement	____	____
7. Adequate precautions taken in component selection and instrument design to minimize corrosion	____	____
8. Calibration and servicing with normally available equipment	____	____
9. Long life components (proven transistors, diodes, etc.) in system	____	____
10. Common signal between the transmitters and control room and back to the control valve	____	____
11. Single instrument to perform the following functions:		
Transmitter	____	____
Recorder, set point, and manual control	____	____
Indicator, set point, and manual control	____	____
Controller	____	____
Valve operator	____	____
12. Cascade control can be added to an installed system without additional panel cut-outs.	____	____
13. Ratio control can be added to an installed system without additional panel cut-outs.	____	____
14. A choice of weatherproof or explosion-proof cases for process mounted equipment	____	____
15. Alarms can be added to an installed system.	____	____
16. Force balance operation		
17. Basic design is explosion resistant.	____	____

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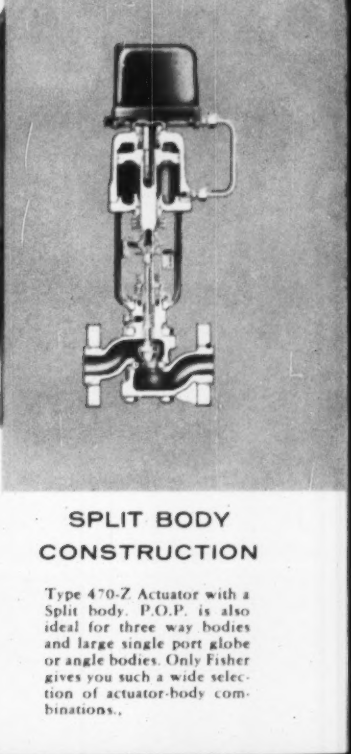
SERIES

470 P.O.P.

PNEUMATICALLY OPERATED PISTON



SPLIT BODY CONSTRUCTION

Type 470-Z Actuator with a Split body. P.O.P. is also ideal for three way bodies and large single port globe or angle bodies. Only Fisher gives you such a wide selection of actuator-body combinations.

Piston Actuator for Control Valves

does jobs that once required giant size equipment!

POWER—Thrusts up to 17,500 pounds available. Delivers same power in either direction at any point of the stroke.

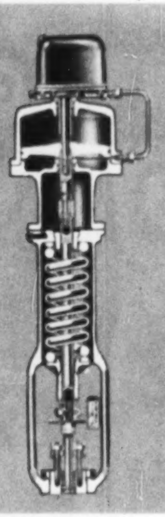
ACCURACY—Maximum Hysteresis 0.15% of stroke or signal. Repeatability 0.03% of stroke or signal. Resolution Sensitivity 0.02% of instrument signal.

SPEED—4 inches per second stroking speed with the Size 30. Size 60 provides 1.5 inches per second.

STABILITY—Built-in intermediate feedback causes proportional band of positioner to be broad while instrument changes are taking place, yet narrow when unit is not in motion.

Here's power plus in a small package! This compact Fisher 470 Series has its own positioner mounted integrally on top of the cylinder. Positioner receives any of the normally used pneumatic instrument signals. Then, without an air set, actuator utilizes the full potential of the available air or gas supply (up to 150 psi) to provide exceptional speed and power.

Series 470 is adaptable to virtually all types of valve bodies including butterfly valves. Easily reversible actuator can be changed in the field. Available in six basic sizes and can be supplied for travel up to 4". Basic actuator can also be furnished with a handjack, hydraulic snubber, pneumatic safety devices or as a spring return unit . . . **Write for Bulletin E470.**



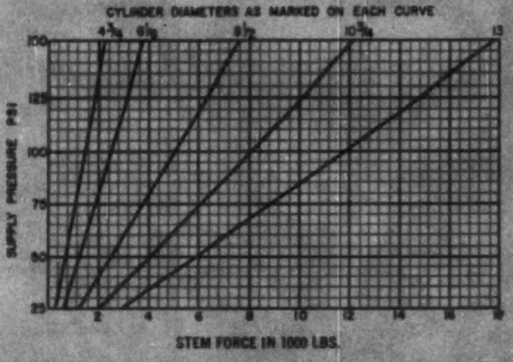
SPRING RETURN ACTUATOR

Type 473 Actuator with spring safety device. In event of a supply pressure failure control valve will move into the closed position. Also available with spring for return to open position in event of plant air failure.

BRACKET MOUNTED SERIES 480 P.O.P.

The versatility of Fisher's P.O.P. actuators is further highlighted in the bracket mounted Series 480. The Series 480 provides a compact, powerful actuator for the operation of butterfly valves, louvers, large rheostats and similar equipment found in many industrial applications.

AVAILABLE STEM FORCE



Besides the five basic sizes shown by the curves, a 17 inch cylinder can be supplied to provide thrusts of 12,000 pounds with a supply pressure of only 60 psi.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / Rochester, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIPMENT COMPANY, CORAOPOLIS, PA.

FISHER® *Controls*

SINCE 1880

A Critical Review of

WARD F. O'CONNOR, The Lummus Company

The following article resulted from an interview with Mr. Ward F. O'Connor, Chief Mechanical Engineer, The Lummus Co., during which he was asked to discuss the development and use of various types of electronic systems for automatic process control. His straight-from-the-shoulder remarks concerning the problems and limitations of some of the systems presently in use, the confusion that surrounded their development and initial use, and his own ideas about how the control problem should be approached make interesting and informative reading.

Mr. O'Connor is exceptionally well qualified to discuss and evaluate control systems by his years of experience with The Lummus Company, where he has been in charge of instrumentation and control for literally hundreds of plants and installations. He has been advocating the millivolt-DC approach discussed in this article to instrument manufacturers for the past four years. He is still striving to obtain the equipment he feels will do the best job for The Lummus Company and other companies with similar control problems. Several manufacturers who have investigated the proposed system are now working on many of the required components. Although equipment is beginning to appear on the market, no manufacturer has yet come up with a complete system incorporating all of the ideas advanced in the article.

The Lummus Company has had several large installations of this type in operation for over two years. The records of these installations have fully documented the advantages and effectiveness of the millivolt-DC system advocated by Mr. O'Connor.

IN the early 1940's it became apparent that pneumatic systems for transmission and control were slow for the large, centrally controlled plants that then were being constructed, as well as others that were planned for the future. This shifted attention to electronic control.

Since that time many types of electronic equipment to provide electric signals and control have been installed and used. This equipment included A-C systems, D-C systems, vacuum-tube units and transistorized equipment. Along with these systems, many data-acquisition units or "scanners" have been employed.

Difficulties soon were encountered in the use of this electronic equipment. First it was discovered that the average engineer (user or manufacturer) found it difficult to specify or purchase and install these different types of electronic systems without running into trouble because of the different principles used. Some pieces had to look at certain levels of impedance or at certain spans of resistance; some operated above ground, some grounded.

Most A-C systems required a multiplicity of "black boxes" in order to accomplish even simple cascades, and a complexity of "black boxes" for more complex cascades (as in boiler-house control). The A-C system also required careful installation to provide continuity of shield. (These extra cares and the complexity of the A-C systems caused the author and some other instrument engineers to specify a requirement that systems be DC.)

When several instrument manufacturers began to market equipment of the D-C type, each used a different signal level for his equipment. As no manufacturer could supply all of the equipment that was required to fill the requirements of different projects, this meant continued mixing of signals and resultant problems.

The user of the equipment had usually been

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Electronic Control Systems

told, and believed, that electronic equipment required a minimum of servicing—so he attempted to service this equipment with no extra training for his service men. We believe, and our records substantiate, that special training of men is necessary if large installations of electronic equipment are to be satisfactorily operated.

The complexity of signals by the various manufacturers and their use in combination was too much for rapid diagnosis of faults by even the best servicemen—and rapid diagnosis of faults is absolutely necessary if suitable "on-stream" time is to be obtained from the plant.

Power-Supply Factors

A most serious fault that we ran into was that some measuring devices required a power supply. Experience has shown that equipment using power supplies in field locations, out of the protection of buildings, are subject to failure. Accidental shorts in a single power supply can trip a breaker that cuts off all power to many other control units on the same circuit.

The probability of such failures increases greatly when conduits are run in the open. Conduits and their fittings "breathe" so that moisture is dropped out with changes of ambient temperature from day to night. Even though systems can be sealed, moisture can collect in switches and terminal strips; this moisture has been a serious source of shorts. There are only two generally used methods of preventing moisture from forming in cavities—by venting to provide circulation of atmosphere or by adding *heat*. With the trend towards use of transistors, we no longer have heat in these locations. Some other causes of shorts include (1) instrument mechanics attempting to service a "hot" system, (2) flash fires, (3) steam cleaning, overheating the wiring and causing it to arc, etc.

There also has been the serious problem of complete loss of power supply. To prevent loss of power, present engineering requirements call for standby battery power, which at present is supplied either by (1) a small battery cell in each controller or (2) a central battery system. The central battery system is much the same as is presently required to operate the main switch gear in a plant. It is obvious that a large battery bank must be used if "hot-tube" circuitry is used in the instrumentation.

The use of a small battery for each controller is more desirable, and is practical with the controllers of the solid-state type. The batteries are maintained charged, and supply power only during emergencies, without operation of or relying on any relays. The design life of the battery may be from ½ hour to 4 hours. Emergency, engine-driven equipment certainly can be expected to be started during this period to maintain charge for the batteries.

In general, low-voltage systems are not as susceptible to shorts, nor are hermetically sealed systems such as can be obtained with millivolt systems employing strain gages. Use of a millivolt system eliminates these and many other problems.

The Millivolt System

A circuit with appeal to instrument engineers is one that measures *millivolts*. Almost all users of control equipment are familiar with the use of millivolts. They have used thermocouples and resistance thermometers and strain gages (for pressure measurement) for years; they understand the equipment; it does not often fail. Even most chemical analyzers generate a millivolt-type D-C signal. Hence the system used should be based on use of millivolt D-C signals for all measurements.

Experience has shown that equipment which a person gets into to adjust or service has a high incident rate of failure and service requirement. This indicated that any device that you could not get into to service, or which had a minimum of levers or adjustments requiring attention, would be a desirable device. The use of strain-gage-type pickups provided us with such a device; all adjustments (zero and span) are done in the control room at the D-C amplifier.

Use of strain-gage-type instruments also eliminated one of the most troublesome requirements for operation of other types of transducers—weatherproofing or steam tracing. In the past, steam tracing has cost us from $500 upwards for each installation. Besides this initial cost, there is still a requirement of continous service to insure protection for each particular installation. Also, the probability of failure of steam heating at the most inopportune time is always present.

There are other advantages in using millivolt systems in interchangeability of units, purchasing, warehousing, and engineering. For instance, people using potentiometers are familiar with the fact that by changing range cards they can move through any desirable ranges of temperature span; for example, they can choose any 300° span from 0°F to 2000°F. Standard potentiometers can read as low as 1.5-mv or 2-mv spans. Strain-gage-type pickups can be purchased so that their total range is 0 to 50 millivolts. Hence, by using a standard potentiometer circuit, any part of this 0-50 millivolts, such as 0-5 millivolts can be read. Also, this 0-5-millivolt signal can be read with a high degree of accuracy. This means that strain-gage transmitters need not have any adjustments; for instance, a 0-300″ inch range can be scaled down from 0-50 millivolts to 0-5 millivolts to read 0-30″ water with a high degree of accuracy. This flexibility of scaling is pointed out to illustrate that all required ranges can be met with a transmitter of only one span in the plant.

The same is true of the strain-gage pressure transmitter or the strain-gage level transmitter where gravity corrections are required. It is because of these points of flexibility and reliability that I have arrived at this *millivolt-DC approach*. It is obvious too, that this approach also lets us feed into data equipment and computers with the highest degree of accuracy and a minimum of complexity.

We have requested of control manufacturers that the equipment be kept as simple as possible and, in particular, that the following design features be used:

1. The controller circuitry should be separated from the recorder circuitry, even if the recorder and controller are in the same case; the controller should be protected so that it is not readily accessible to unauthorized hands. The recorder is accessible and, since it is accessible, it is expected that it will require some maintenance. These requirements are based on a lesson that we have learned from harsh experience—a device that can be entered into requires more service. It is absolutely necessary that control be maintained with secondary importance on recording.

2. With each controller there is usually a manual control station. Complex switching must be eliminated from the manual control station.

3. The so-called "seal" position that was necessary with the miniature pneumatic controller is not necessary in electronic equipment and is a hazard; it should be eliminated. (I have requested instrument manufacturers to eliminate this even in pneumatic control circuits.)

4. The manual control station should have its own set point; one that is not a part of any other function. A simple on-and-off switch type of operation should be employed for switching from automatic to manual, or from manual to automatic.

5. It is necessary that we go back to the type of *set-point-detection* system used in the large-case pneumatic units where a separate panel was used for manual control. Set-point detection can be described as a means of mechanically aligning the set point with the transmitter signal, as was done with the early pneumatics. Moving the set point past the transmission signal would cause the controller output gauge to flip from one end of the gauge to the other. For some reason or other, instrument engineers and manufacturers have been overlooking the fact that bumpless transfer is really necessary when going *from* manual *to* automatic; they have been stressing in their thinking that bumpless transfer is necessary only when going from automatic to manual and their equipment is so designed.

6. Almost invariably, when a plant operator switches from automatic to manual, he does so because the system is not performing as it should. So he does not wish to go to manual at exactly the same position as in automatic control. Frequently he wishes to go to manual at a much different position; sometimes as much as 50% to 80% different. This feature requires a separate set-point for manual control. The separate set-point also provides the operator with a memory system for his normally operating control output. Large installations of controllers have too many points for the operator to remember in cases of trouble.

Advantages of Millivolt-DC System

In summary, this millivolt-DC system (1) requires minimum maintenance and a minimum of understanding of electronic systems by the user, (2) will ride through power failures, (3) provides the board operator with the system for automatic control or manual control that he needs, (4) requires a minimum amount of engineering of a repetitive nature, (5) provides flexibility in use because of standard components, and (6) provides a usable system for all data or computer manufacturers.

My personal experiences with several hundred millivolt strain-gage-type pickup control systems over the past two to three years has indicated that this system may be the best available to date.

The Strain-Gage Transducer

EDGAR S. GILCHRIST, deVar Systems, Inc.

THE STRAIN GAGE has several advantages over other types of transducers for the measurement of flow, pressure, level, etc. One outstanding advantage is its insignificant mass, which makes it resistant to acceleration and vibration error. Furthermore, its motion is only a few thousands of an inch and the signal output leads can be brought out of a high-pressure environment without resorting to the critical leverage systems necessary with mechanical systems. Not only can the repeatability be improved and the error due to vibrations in line pressure reduced, but the strain gage is much smaller and simpler to install.

Moving coil or moving armature force-balance transducers are inherently responsive to acceleration because of the unavoidable inertia of their moving parts. Variable-reluctance transducers also have a moveable iron slug, which may travel as much as .050″.

deVar System has thus selected the strain gage as its basic transducer for its line of process control instruments. Other features in the line include (1) amplifiers with both a-c and d-c output, the former for use with recorder controller and alarms, the latter for data loggers and computers, (2) recorders using a-c rotary transformer and torque motors, (3) 18-volt d-c power supply.

Mr. Edgar S. Gilchrist, Chief Engineer and General Manager of deVar Systems, Incorporated, Glenbrook, Connecticut. Mr. Gilchrist is holding a torque motor used as the pen drive in the new deVar Recorder.

Additions to our Timer Survey:

The Dialtron thermal time delay relay (Fig. 1) uses longitudinal expansion in response to variations in current introduced into the heating element (2) on the primary actuating member (1). The secondary control member (3) is relatively unheated and can rotate around an adjustable pivot (4). The switch element arm (5) is connected at one end to the secondary member (3), and has a contact (6) at the other end. Heater voltage can be up to 150 volts DC or AC, any frequency. Tolerance:

Time Delay 1-5 seconds.

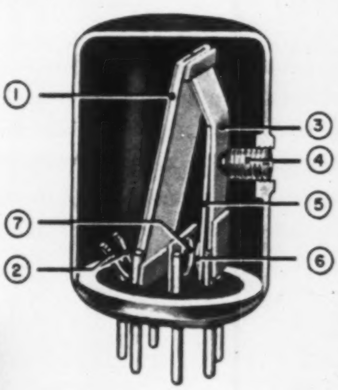
$$\text{Ambient}\begin{cases}-\ 65^\circ\text{C to } +\ 100^\circ\text{C: } \pm\ 20\%\ \text{tolerance.}\\ +101^\circ\text{C to } +\ 125^\circ\text{C: } \pm\ 30\%\ \text{tolerance.}\end{cases}$$

Time Delay 6-300 seconds.

$$\text{Ambient}\begin{cases}-\ 65^\circ\text{C to } +\ 100^\circ\text{C: } \pm\ 10\%\ \text{tolerance.}\\ +101^\circ\text{C to } +\ 125^\circ\text{C: } \pm\ 20\%\ \text{tolerance.}\end{cases}$$

Fig. 2 shows transistorized time-delay relays offered by Plug-in Instruments, Inc. Models include units with ranges adjustable from less than 0.1 to more than 1 second; to 10 to 100 seconds. Repeatability is better than 2%. Features include models with slow-make and instant-break, instant-make and slow-break, ac or dc input with dc output, etc.

FIG. 1.



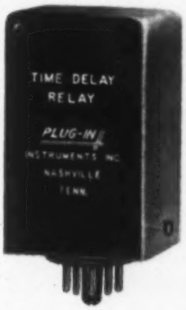


FIG. 2.

NO POTS AT ALL

V44 - the new, ultra-stable, all-electronic digital voltmeter

No longer must you trim decade or amplifier gain potentiometers to make accurate, high-speed measurements with an all-electronic digital voltmeter. The new transistorized NLS V44 has *no pots at all* in its decade circuits because of ultra-stable electronic switches . . . *no pots at all* in the amplifier because amplifiers are used only within the feedback loop, where amplifier drift becomes inconsequential. Here is the speed you need — 3 milliseconds per reading — for measuring high-speed transient data . . . for multi-channel data logging. Contact NLS for complete information.

BRIEF SPECIFICATIONS: Accuracy ±0.01% . . . speed 3 milliseconds per reading . . . input impedance 10 megohms . . . "anti-jitter" circuit . . . DC voltage ranges ±9.999/99.99/999.9 . . . millivolt ranges with preamplifier ±99.99/999.9 . . . AC ranges with AC/DC converter 9.999/99.99/999.9 from 30 cps to 10 kc . . . 98% plug-in modular construction . . . digital output in both decimal and binary coded decimal form . . . simple plug-in accessories for automatic data logging and measuring systems . . . complete, $6,150.

Originator of the Digital Voltmeter
non-linear systems, inc.
DEL MAR (SAN DIEGO), CALIFORNIA

CIRCLE 72 ON READER-SERVICE CARD

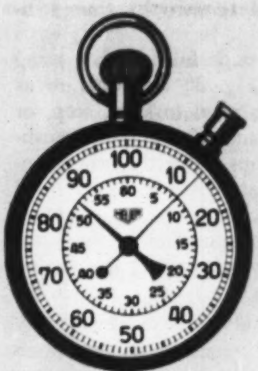


FIG. 1. BASIC stopwatch.

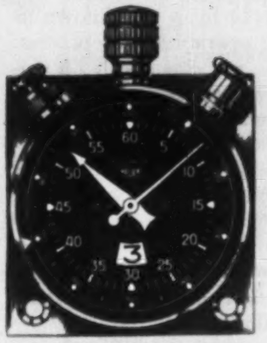


FIG. 2. WATCH with hour disk. Reading is 3 hr, 52 min, 8⅖ sec; or 3 hr, 52.14 min.

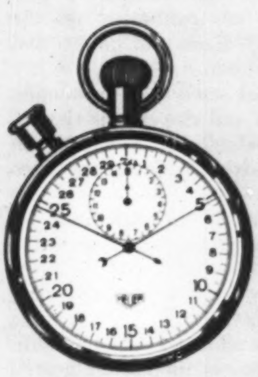


FIG. 3. SPLIT-ACTION watch has one hand which times conventionally. At first actuation of side button, one hand stops while other continues. At second actuation the stopped hand rejoins other.

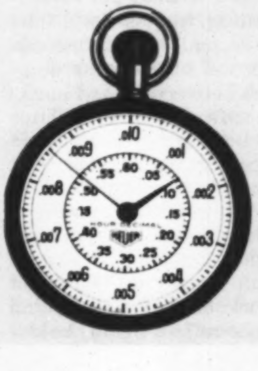


FIG. 4. HOUR-DECIMAL watch. Each unit indicates 1/10,000 hour.

Manual Timing Techniques

Time is important in nearly every problem, every process and every phenomenon. In many cases it is measured with a stopwatch. Here are basic manual timing techniques—cumulative timing, instantaneous sequential timing, hours indications, split-action timing, and recording techniques.

GASTON G. WILEY and JACK W. HEUER, Heuer Timer Corporation

THE BASIC MANUAL TIMER consists of a good movement in a case. A crown serves the double purpose of winding and controlling the counter mechanism; successive depressions of the crown causes the timer hand to start, to stop, and to fly back to zero. Note that three depressions of the crown are required for one cycle of interval measurement in the basic timer.

The most common variation of the basic timer provides *cumulative timing*—successive depressions of the top crown start, stop and start the hand again without return (go-on) for cumulative timing purposes. A pushbutton or slide at the side of the crown returns all hands to zero.

Another variation permits timing *sequential intervals* without any loss of time between intervals—as in production uniformity studies. This is done by having the timing hand start immediately after the fly-back without an additional depression of the crown. Here, a side button is used for start, stop and go-on.

A panelboard model (Fig. 2) introduced recently carries an hour disc; up to 12 hours can be timed to 1/5 second. The hour disc jumps from position to position to show the hour as a numeral through a window in the dial. (In Fig. 2 the reading would be 3 hr, 52 min, 8 2/5 sec—or 3 hr, 52.14 min—depending on whether the sweep hand is read on the inside seconds-and-fifths circle, or on the outside decimal-parts-of-a-minute circle.) In this instrument an auxiliary pushbutton at the left of the crown returns the hour-disc to zero. The two

TABLE 1—UNITS, CAPACITY, BEATS AND GEARING

GEARING (sec/rev)	BEATS (beats/sec)	DIRECT READING (dial unit)	REGISTER CAPACITY
100	4	1 sec	100 min
60	5	1/5 sec or 1/100 min	60 min and 12 hr
36	8	1/10,000 hr	0.60 hr (36 min)
30	10	1/10 sec	30 min
10	20	1/10 sec	10 min
6	50	1/1000 min	6 min
3.6	100	1/100,000 hr (one TMU)	0.04 hr (144 sec)
3	100	1/100 sec	3 min

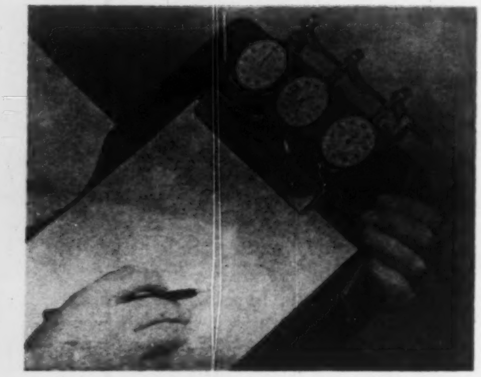


FIG. 5. **CLIPBOARD**-mounted stopwatches.

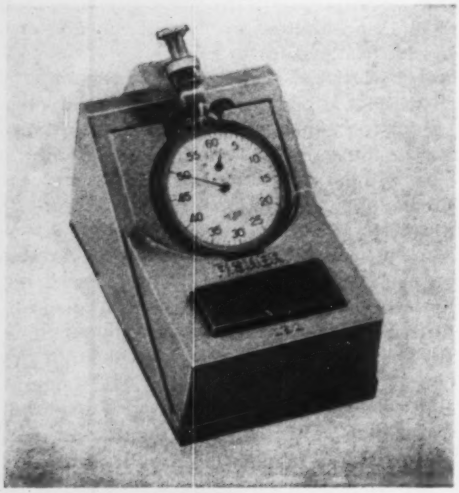


FIG. 6. **STAND** with tap plate.

pointer hands are returned to zero by the push-button at the right.

In *split-action timing* two full-length sweep hands are superimposed (Fig. 3) and operate as one when the top crown is used to start, stop, or reset. However, at the first actuation of a side push-button one of the hands stops while the other continues; at the second actuation the stopped hand rejoins the main hand (which may still be in motion or now at rest). Thus, it is possible to time one phase of a process without disturbing the timing of the over-all process. This is a type of cumulative timing with ability to time portions of the cumulative interval.

Features

In most stopwatches the balance wheel and escapement are at rest (held by a part known as the whip) unless a timing operation is in process. Thus, the full wind of the movement can be employed for timing purposes. Some users prefer the constantly-running stopwatch and aver that it gives greater precision. The sweep hand is "clutched in" at the start of a timing operation. Such movements are frequently found in split-action timers and in stopwatches with chronometric (time-of-day) features.

In newer models the minute register circle is around the same central shaft as the sweep-second hand; this improves legibility.

In industrial models, the sweep circle is generally divided into decimals (hundredths) of a minute rather than in seconds and fifths. This is more convenient for conversion and simplifies slide-rule and calculator operations. Some time-study and production-work stopwatches are calibrated on the hour-decimal basis (Fig. 4). Each unit on the dial indicates 1/10,000th of an hour.

A common auxiliary dial used for production timing (and also by pilots and drivers) is the so-called *tachometer scale,* which reads directly in production rates (or speeds) based on the time required to produce (or traverse) a single unit. The common calibration is from 60 to 1000 units per hour. Its application in industrial instrumentation is increasing.

Users can choose from several available *frequencies of beat* (steps per second of sweeping hand), and also gearing. In addition to the familiar 60-seconds-per-revolution timers, models are geared for 100, 36, 30, 10, 6, 3.6, and 3 seconds per revolution (with appropriate beating frequencies). The most familiar beat is 5 per second (which one can observe on the basic 1/5-second timer as the number of jumps the hand makes between second markings). Other stopwatch specifications can call for 4, 8, 10, 20, 40, or even 100 beats per second. Table 1 relates beats, seconds-per-revolution, the dial units, and capacity. The user can select the best one for his needs.

Stopwatches are now offered in two sizes—the new and more-legible 2″ dial is taking preference over the traditional 1¾″ dial. Timers now have flat backs (so they do not rock on the table), dull black finishes (which do not reflect light), bolder and simpler markings, and full shock protection (through Incabloc shock-resistant jewel mounting of the balance wheel).

Federal Specification

A new Interim Federal Specification for Stopwatch, Laboratory (GG-S-00764; September 3, 1959) has been published by the National Bureau of Standards to improve its older stopwatch standard (GGW-111a, Amendment 2, October 5, 1939). Though not severe by precision horological standards, the new specifications cover jewels, dustproofing, accuracy, shockproofing, temperature range, and other items sufficient to insure good quality. A worthy timer manufacturer can guarantee precision within one beat in 10,000 (approximately ⅓ sec per hour of timing).

Timing Techniques

Remote actuation, sequencing and mounting are three important manual timer techniques.

The flat back and the drilled mounting plate (Fig. 2) represent minor revolutions in stopwatch design. The latest development is a strong permanent magnet integral with the back so that the watch will cling to any ferrous panel in any position. Stopwatches also can be mounted on clip boards by clamps (Fig. 5). Laboratory supply houses offer stands (Fig. 6) with tap-plate actuators; pressing the plate below the watch actuates the crown.

Accuracy in manual timing depends on the operator as well as the instrument. Human reaction is sufficiently rapid that a twitch of the hand of a practiced observer can follow a "surprise" event within 1/10 second. Timing can be even more precise if the event is gradually approached and the operator can anticipate the moment of actuation. Errors due to parallax are negligible in manual timers so long as the observer's eye is close to a projection of the axis of the central shaft (the face at right angles to the line of vision).

Sequencing can be accomplished by 2-watch, 3-watch, or split-action-watch methods. In three-watch sequencing the three watches must be set up as shown in Fig. 7. A is at zero, ready to start; B has been started, stopped, and is ready to fly back; C is running. The three watches are actuated hereafter at precisely the same instant with a single squeeze of the left hand of the observer, leaving the right hand free, as in Fig. 5. Fig. 7 explains the operation. When the bar is depressed (starts step 1), timer A starts, B flys back, and C stops. At the next depression (end of step 1), A stops, B starts and C flys back. A (step-1 interval) now can be read at leisure while B is timing the second interval. At end of step 2, pressing the bar stops B and starts C; A returns to zero. B now can be read at leisure to give the step-2 interval, while C times step 3. Similarly, any number of intervals can be timed in sequence. Each step in the sequence of steps under measurement is timed in with the same motion by which the preceding step is timed out; there is zero time loss between steps.

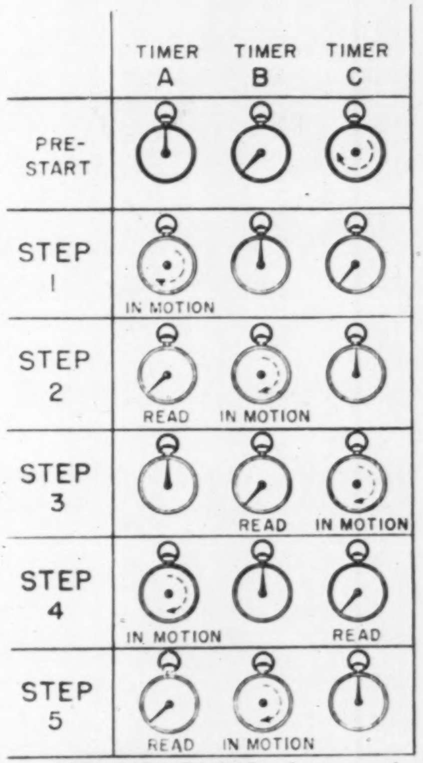


FIG. 7. SEQUENCE TIMING of any number of intervals with three watches. First reading (clock A, step 2) reads step-1 interval; second reading (clock B, step 3) reads step-2 interval; third reading (clock C, step 4) reads step-3 interval; etc.

When the observer has no time to devote to reading stopwatches it is often desirable for the observer to make the motion which stops one interval and starts another, but to have a laboratory assistant read the watch stopped at the termination of each interval and record the data.

If one has an assistant to record the data, sequence timing is possible with two watches, one held in the left hand and the other in the right. At the beginning of timing, one watch must be at zero and ready to go, the other stopped at some positive point and ready to fly back. With a little practice the crowns of the two watches can be depressed simultaneously with less than 1/10-second difference. At the conclusion of each interval the stopped watch must be read and returned to zero independently. The reading must be called vocally and recorded by an assistant, unless there is a considerable interval between events.

With a split-action timer, sequence timing is inherent in the one watch, and the interval data are cumulative.

Manual versus Automatic Timing

Manual timing is more useful for getting information than for controlling a process (unless it is economic to use the human animal as the feedback link). Control is the domain of automatic timing; intelligence is the domain of manual timing.

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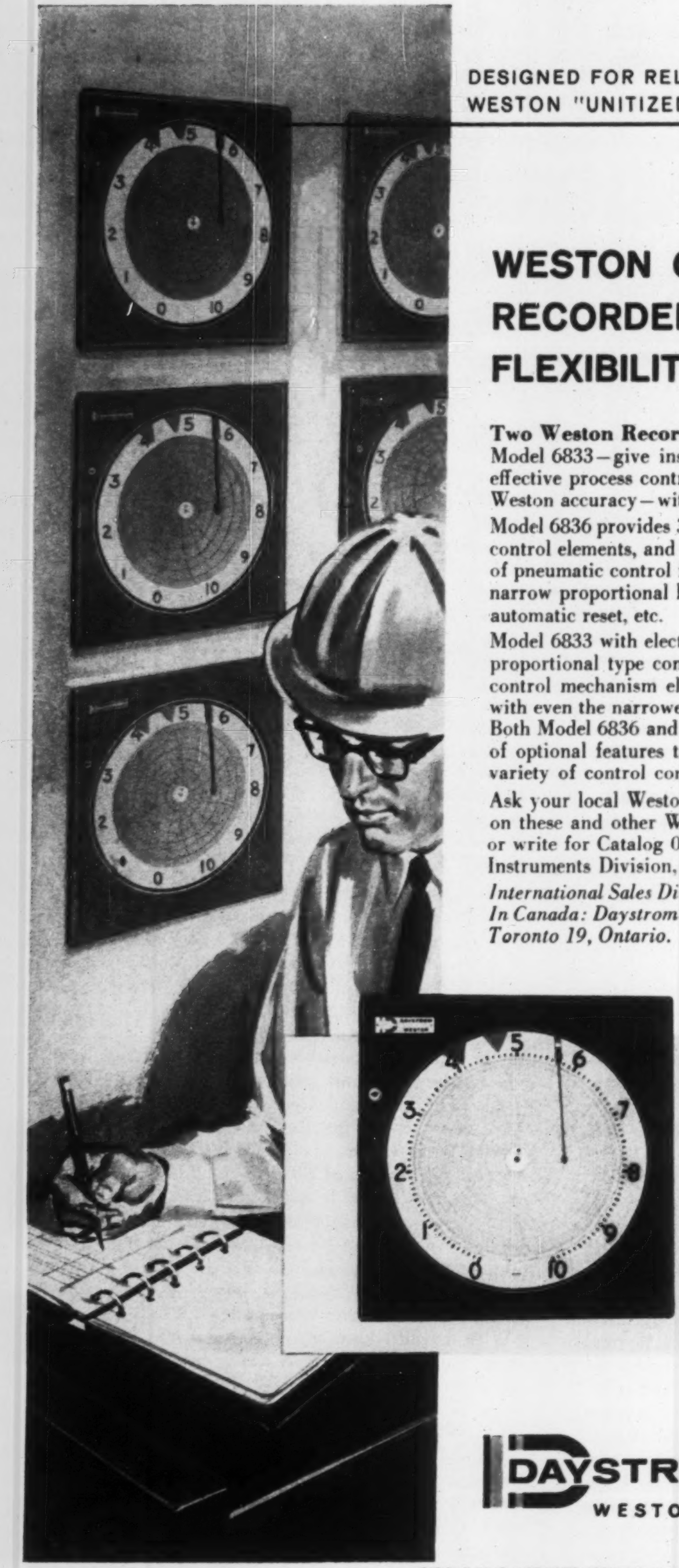


WESTON CIRCULAR CHART RECORDERS OFFER MAXIMUM FLEXIBILITY OF CONTROL FORMS

Two Weston Recorder-Controllers—Model 6836 and Model 6833—give instrument engineers needed versatility for effective process control. And, of course, both feature Weston accuracy—within ±¼% of span or ±.025 mv.

Model 6836 provides 3 to 15 psi pneumatic output for final control elements, and is available in a complete range of pneumatic control forms, such as on-off, differential gap, narrow proportional band, proportional band with automatic reset, etc.

Model 6833 with electric control is available in contact or proportional type control. Unique design of the control mechanism eliminates chatter due to vibration with even the narrowest differential.

Both Model 6836 and 6833 are designed for the addition of optional features to accommodate a great variety of control configurations.

Ask your local Weston representative for complete information on these and other Weston instruments for industry, or write for Catalog 08-101-A. Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey.

International Sales Division: 100 Empire Street, Newark 12, N. J.
In Canada: Daystrom Ltd., 840 Caledonia Rd.,
Toronto 19, Ontario.

Model 6836 (illustrated) and Model 6833 are supplied in potentiometer or Wheatstone Bridge types. Scale: 320° concentric, 33.86" long. Chart speed: 1, 4, 8, 12, 24, 48 hours or 7 days per revolution.

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION

CIRCLE 73 ON READER-SERVICE CARD

Process Control Systems

FRED D. MARTON, Instruments Publishing Company

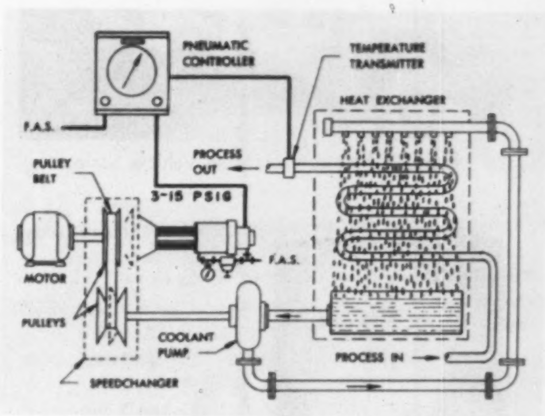
FLOW OF COOLING WATER REGULATED BY ADJUSTMENT OF VARIABLE-SPEED DRIVE ON PUMP

Flow of cooling water in a heat exchanger can be controlled by a variable-speed drive which links a constant-speed motor to a circulation pump. The variable-speed drive has a split pulley which is positioned by a pneumatic cylinder actuator.

The cylinder receives a 3-to-15 psig pneumatic control signal from a temperature controller. The sensing element (such as a filled bulb) is located in the process line. A pneumatic temperature transmitter is used when the distance to the remotely-mounted controller is more than 200 ft.

Control mode is usually proportional only. However, rate and reset are available where rapid changes in the temperature of the process medium are required.

Equipment used: Conoflow Series 50 Cylinder Conomotor; variable-speed drive (any make) pneumatic controller (any make); pneumatic temperature transmitter (any make).

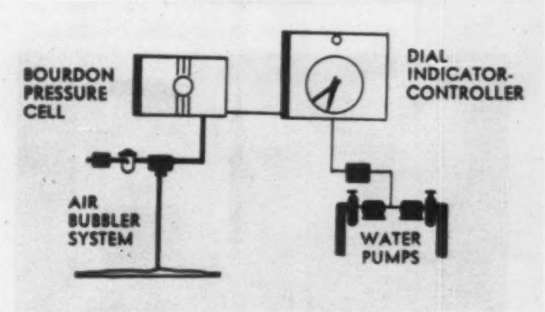


Source: Conoflow Corp., Phila., Pa.; also Bulletin B-50-3.

BUBBLER KEEPS DOCKS AND BILGES DRY

Due to leakage and tides, water accumulates on the bottom of dry docks and has to be removed. The U. S. Navy solved this problem by an automatic control connected to an air-bubbler system. As the water rises, pressure in the bubbler system is measured by a bourdon tube (range 0-30 psig), which actuates a linear differential transformer. The transducer sends an electric signal to a remotely-located indicating controller, calibrated 0′-75′ water depth. The control operates 2 sets of pumps. When the indicating pointer reaches the first control contact the first set of pumps goes into operation and discharges the water from the bottom. When the rise is too rapid to be handled by these pumps a second control contact is reached by the pointer, whereby operation of the second set of pumps is started. When the water level drops, the pumps automatically cut out.

Instruments: Bubbler system (with flow regulator); ATC bourdon pressure cell with differential-transformer; ATC dial-indicator controller (on-off model); Pumps.



Source: Automatic Timing & Controls, Inc., King of Prussia, Penna.; also Application Bulletin 154.

Additions to article

LATE DEVELOPMENTS IN WEIGHT INSTRUMENTATION

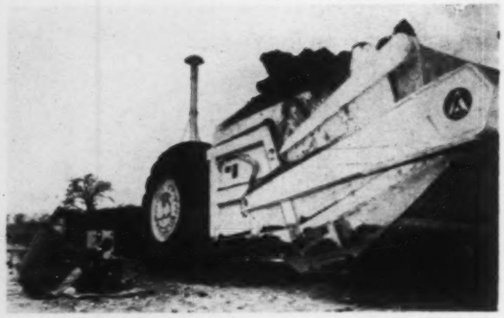


FIG. 1. Ametron portable vehicle scale.

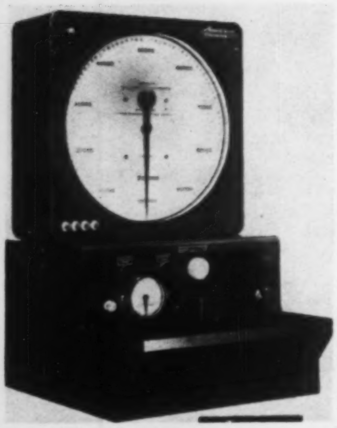


FIG. 2. Ametron electronic weighing system.

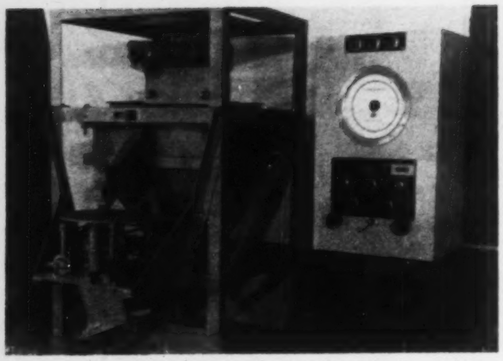


FIG. 3. Compudyne pneumatic load cell on hopper scale, with control panel.

Streeter-Amet

New "Ametron" equipments include electronic weighing systems and portable vehicle scales.

The Portable Vehicle Scale (Fig. 1) is a compact weighing system comprising (1) a portable weighbridge platform containing strain-gage-type load cells, and (2) a carrying case which contains the instrument (bridge) and accessories. The system can be set up and operating in less than five minutes. It can be plugged into a standard automobile cigar lighter or attached to the battery directly. Power drain is the same as that of a standard automobile radio.

Streeter-Amet also offers its newest line of weighing equipment—"Ametron Electronic Weighing Systems," also based on load-cell weighing. Fig. 2 shows a typical system with printout. These systems are custom designed to conform to the customer's requirements (crane, truck, hopper, tank, track, etc.) and can include remote stations, identification, multiple ranges, automatic balance, push button zero adjust, calibrated tare adjustment, and predetermined value control. Weights can be printed on tape or ticket, visual, or a combination of both. The line is rounded out with revolution counters, time interval counters, totalizers, etc.

Weighing and Controls

Weighing and Controls, a division of CompuDyne Corp. (formerly CDC Controls) offers weighing system based on both strain-gage and pneumatic transmitters*. Fig. 3 shows a basic pneumatic transmitter, used with a hopper scale with control panel. Conveyor weigher feeders also are offered.

Advantages of the pneumatic system include: (1) temperature sensitivity less than that of strain-gage-type load cells, (2) long life and high corrosion resistance because of continuous purge of air and absence of pivots and knife edges, (3) calibration is built-in and cannot change, (4) reproducibility is 1 part in 5000 and accuracy is 0.1%, (5) range can be extended by addition of extra chambers for tare and net weighing, (6) complete over-range protection via stops, (7) mountings that restrict motion to vertical motion and which meet rugged industrial requirements, (8) pneumatic or electrical connections can be made to a central control station, (9) central control station can provide totalization, computing, ratioing, blending, card punch, programming, etc.

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*The pneumatic transmitter was described previously.

Load Cell Calibration Facility will Measure Loads to 250,000 Pounds with 0.01% Accuracy

The highest-capacity dead-weight-testing facility in the world for calibrating load cells is under construction at the Electronics and Instrumentation Division, Waltham, Mass., of Baldwin-Lima-Hamilton Corporation. The new facility will provide a primary standard for measuring applied loads in tension or compression from zero through 250,000 pounds. (The present NBS limit of primary standard force measurement is 111,000 pounds.)

Expected accuracy of the new facility will be ±0.01% of load anywhere in the range. This compares favorably with the accuracy of primary standards presently in use for much smaller load ranges.

The facility will include two basic machines. The first, using a dead-weight arrangement, will cover the range from zero through 25,000 pounds with intervals of 500 pounds. The other machine will cover from zero through 250,000 pounds with 5,000-pound intervals.

The 250,000-pound machine, which will employ dead weight of 130,000 pounds, is conventional up to that capacity. Beyond the 130,000-pound mark, the machine is unique. Its load generating range is extended to 250,000 pounds through use of a BLH SR-4 load cell which superimposes a precisely metered additional load upon the load applied by the dead weight. By a process similar to substitution weighing, the transfer cell permits theoretical extension of the range of the dead weights to an arbitrarily high figure.

NBS is providing the weights for the new facility, which will be adjusted to accuracies better than 0.005%.

BLH states that the assured reproducibility of load generation anywhere between 130,000 and 250,000 pounds will be within 0.025% of actual load, and the probability is that of actually achieving 0.01% of load anywhere in the range.

The generation of a 250,000-pound load, which can be performed in a few minutes, will be in this manner:

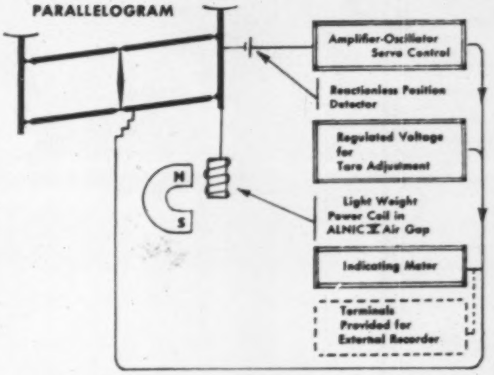
A. A 120,000-pound dead weight is applied first directly to the transfer cell, thereby calibrating it.

B. A dead weight of 130,000 pounds then is applied to the cell under test.

C. Using the just-obtained calibration of the transfer cell, an additional 120,000 pounds of load is superimposed upon the cell under test.

Minnesota Instrument Co.—Minneapolis

Fig. 4 shows a new MINSCO direct-reading balance, which uses the flexure pivot balance principle plus a moving coil in a magnetic gap. Motion of the coil, caused by deflection of the balance pan, produces a d-c current which depends on both the amount and rate of beam movement. The current, which becomes a position-restoring force, is indicated on a meter. The beam is rebalanced to neutral position and reaches equilibrium in a few oscillations, permitting read-out in about 3 seconds.


PARALLELOGRAM
N
S
Amplifier-Oscillator Servo Control
Reactionless Position Detector
Regulated Voltage for Tare Adjustment
Light Weight Power Coil in ALNIC V Air Gap
Indicating Meter
Terminals Provided for External Recorder

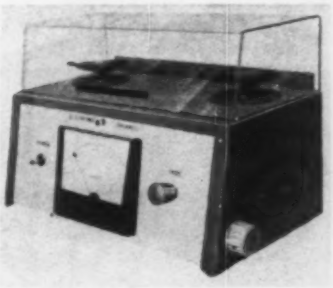


FIG. 4. Minsco direct-reading balance.

Ranges are available from 1 gram (with 2-mg sensitivity and 15-mg accuracy) to other models with 10-grain range. An electrical vernier provides tare adjustment. External recorders can be attached.

National Conferences on Weights and Measures

The conference, which was organized in 1905, is sponsored by the National Bureau of Standards and brings together weights and measures officials, as well as representatives of business and industry. Model laws, specifications, tolerances, regulations, and enforcement practices are recommended by the conference for adoption by the various states, which have the legal responsibility of regulating commercial weighing and measuring devices, and of controlling commercial transactions involving quantity. The National Bureau of Standards, through its Office of Weights and Measures, cooperates with the States in this endeavor by providing reference standards, calibration service, and a wide range of technical advisory programs. Thus, the national standards of length and mass, which are in the custody of the Bureau, are translated into everyday use.

The 45th National Conference on Weights and Measures was held June 6-10, 1960. Secretary of Commerce Frederick H. Mueller gave a set of measurement standards to the new State of Hawaii.

The mass standards, of specially designed Nichrome, ranged from 30 pounds down to one millionth of a pound, avoirdupois weight. The standards also included a yard bar and a 100-foot measuring tape representing length.

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DEGREES FAHRENHEIT

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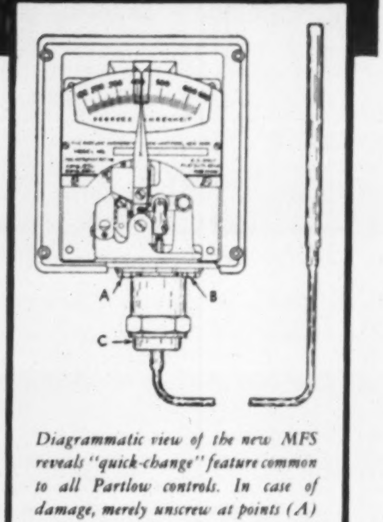
Right on the Job!

Rugged simplicity of design—along with the direct, positive power of mercury-actuation — combine to give Partlow maintenance and performance advantages no other type of temperature control can hope to equal.

Simplicity in the Partlow, for one thing, means that the control element can be changed *at the job site* in a matter of minutes with no other tool than a screwdriver . . . "Down time" is cut to an absolute minimum!

And simplicity in the Partlow also means the complete elimination of fussy electronic gadgets, delicate levers, hairsprings and other accessories that have a tendency to break down at the first trace of jar or jostle. Partlow controls are famous for their unfailingly accurate performance even under the most adverse operating conditions.

If you use or manufacture process equipment within the -30° to 1100° F. range, there's a Partlow pneumatic, electric or self-contained gas control (recording, indicating or non-indicating), to fit your application *precisely*. For details, write The Partlow Corp., New Hartford, New York. Dept. IA-1060.



Diagrammatic view of the new MFS reveals "quick-change" feature common to all Partlow controls. In case of damage, merely unscrew at points (A) and (B), and remove element (C) from case. Reverse this process, and your Partlow is ready to resume operation.

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PARTLOW

TEMPERATURE CONTROLS

CIRCLE 74 ON READER-SERVICE CARD

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THE AUTHOR

Mr. Percy is a sales engineer specializing in chromatography with the Barber-Colman Company. He previously worked in the Chemical Engineering Department of C. F. Braun & Co., and as an application engineer of Consolidated Electrodynamics. He is a registered Professional Engineer in California and Texas. He received a B.Ch.E. in 1942 from Syracuse University.

Sample-System Design

Sampling systems must present an analyzer with as representative a sample as possible, with the least dead time.

L. EARL PERCY

A SAMPLING SYSTEM should perform the following functions: (1) Take from the process stream a sample which is representative of the composition of that stream. (2) Transport the sample to the analyzer and then to the desired point of rejection at the proper rate. (3) Prepare the sample so that it is in the proper form chemically and physically when it reaches the analyzer.

Obtaining a representative sample requires proper sample-point location and consideration of chemical changes occurring coincident with sampling. The transportation of the sample is mainly concerned with system time lag, which is related to system volume, sample flow rate, and amount of sample. The alteration of the sample requires consideration of pressure, temperature, composition, cleanliness, and homogeneity of phase.

In a control application, we must consider the contribution to the closed-loop dynamics made by the analyzer and sampling system. The analyzer is only as reliable as the sample supplied.

Sample-point Location

Select a sample point to (1) supply the cleanest possible sample, (2) avoid pick up of unnecessary water, (3) be representative, and (4) minimize control-loop time lag.

The location of the sample point is most critical when the analyzer becomes part of the control loop. Generally a tray composition will respond more rapidly to change in a process variable than will the overhead product. Select a point on a column that will produce the greatest composition change per unit change in process variable.

The sensitivity of the process is determined by studying the column profile for the greatest slope of the concentration gradient. Study all information available concerning the amount of concentration-gradient shift with change in feed composition. Variations in concentration of minor components in the sample may change the measured concentration-gradient by changing the response to the controlling process variable.

In the theoretical design of a column, the transient behavior of any control loop can only be estimated with frequency-response and analog computation methods. The effect of the analyzer and its accompanying sample system on the transient behavior of the control loop is at best a guess. While an educated guess can be made, it would be expedient to supply a number of alternative sampling points for possible future use.

Choose the sample point that will provide the quickest response to a change in a process variable to maintain a more constant product. This applies to both monitoring and control applications.

The site of laboratory sampling should be selected also to avoid discrepancies in results between lab and plant measurements.

Sample Transportation

The amount of sample required is dictated by the analyzer used. It is necessary to minimize any time lag introduced by the sampling system; high sample flow rates and small system volumes are necessary. All necessary pressure regulation of the sample

Meeting Notice: Thursday evening, November 17, 1960, 8:00 p.m. Rio Hondo Country Club, Downey, Calif.
Speaker: Mr. Jacob E. Valstar, Hughes Aircraft Co., Semi-Conductor Division, will present a paper on "Modern Techniques in Control Engineering."

Presented at Southern California Meter Association Short Course at Los Angeles Harbor Junior College, April 13, 1960.

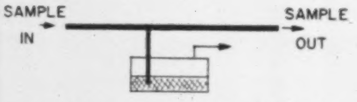


FIG. 1. SAFETY pressure release.

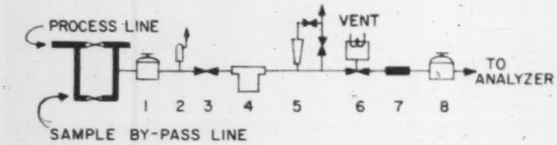


FIG. 2. TYPICAL SAMPLE system—(1) pressure regulator, (2) relief valve, (3) block valve, (4) filter or drier, (5) flowmeter for sample bleed, (6) solenoid valve, (7) filter, (8) absolute pressure regulator.

should be done at the sample point to produce smaller sample volumes and faster flow rates.

The sample flow rate will be a compromise between (1) the amount of sample that is required by the analyzer, (2) the pressure drop across the vent line, (3) the length of sample line, and (4) the capacity of the system components used for sample treatment.

The sample flow rate can be controlled by several means. A simple method is to control the upstream pressure from a variable orifice and vent to atmosphere. Commercially-available differential-pressure flow controllers are satisfactory and can be used in most cases.

Sample disposal may pose a problem. It is preferable to return the sample to the process at a lower-pressure point. However, it may be necessary to use a pump or a steam ejector if a lower-pressure point cannot be found easily. When the analyzer sample is at atmospheric pressure, use a safety pressure release (Fig. 1) to protect the instrument from pressure surges.

In choosing equipment for sample handling, consider materials of construction that will avoid sample contamination and corrosion.

The analyzers can provide multistream analyses only if the streams are reasonably identical in major constituent concentration. Selection of the stream to be anlayzed can be made manually or by preprogramming a schedule with a multipoint recorder.

Sample Dynamics

Frequency-response techniques in the study of the dynamics of a control system show that dead-time terms are the predominant factors in closed-loop stability. Any time lag introduced by the sampling system is considered dead time. This must be kept at a minimum by keeping the sample lines small and short, and the sample flow-rate high. All sample-preparation equipment also introduces dead time. The sample system can introduce a large time factor that can change the control loop dynamics when added to the analyzer time lag.

It is easy to visualize the response of the sample line itself to a step change in concentration of the material of interest. When the pressure drop across the line remains constant, the flow volume will remain constant. This is true if the viscosity remains unchanged for laminar flow, and the density remains unchanged in the turbulent flow region.

Under these conditions the average velocity with which a new concentration of sample proceeds down the tube is:

$$V_{av} = Q/A$$

where Q is volume flow rate in tube, A is cross-sectional area, and V is velocity.

The response of the sample tube to a step change in concentration is pure dead time.

$$\tau_o = V/Q$$

where τ_o is dead time, V is sample line volume, and Q is volume flow rate in tube.

When a volume is introduced in the sample line from such components as filters and traps, the dead time is increased by an amount equal to the volume of the element divided by the volume flow through it. Thus the total dead time becomes

$$\tau_D = \text{Total sample volume/Volume flow rate in tube}$$

If it is necessary to locate the analyzer a considerable distance from the process, the dead time can be reduced by bringing the sample close to the analyzer with a large-diameter bypass pipe. The sample line is tapped into this pipe close to the instruments. Thus a small flow-rate through the analyzer is permissible without excessive dead time.

It is best to regulate the pressure at the sampling point to provide a smaller volume of sample to be handled by the system between the sampling point and the analyzer. Dead time can be reduced further by partly venting the sample line at the analyzer to increase the flow rate of the sample to the instrument. A typical sampling system is shown in Fig. 2.

Sample Preparation

It is necessary to prepare a sample properly for analysis due to the delicate and sensitive nature of the analyzers. Preparing a sample for the analyzer comprises: (1) removing particulate matter (to protect any optical surfaces), (2) removing corrosive materials (whenever possible), (3) removing entrained water, and (4) vaporizing (if necessary). The methods suggested below are only guides.

Solid Entrainment

Entrained particulate matter can be removed from a gaseous sample by filtering (Fig. 3). A rough glass wool or ceramic filter will remove the bulk. The rough filter should be followed by a fine sintered stainless-steel filter which will remove matter in the range of 7-10 microns in size. The rough filters are equipped with drains to remove condensation and liquid dropout.

An alternate method of removing solid particle entrainment is to use a miniature cyclone separator with a silicon-carbide filter on the outlet. Solids are removed from the cyclone with a bypass stream from the bottom of the unit returning to the main sample line at a lower-pressure point. The primary disadvantage is that a cyclone requires a high pressure drop and high velocities.

Water Entrainment

Small knockout pots with excelsior-packed filters sometimes are used to remove entrained water. The bottom is drained continuously to a lower-pressure point in the process. The pots then are followed by an upflow sand filter to remove further traces of water. This produces a gas saturated with water. The sample lines then can be steam traced and insulated to maintain the lines 30° to 50°F above the water saturation temperature.

Fig. 4 shows an alternative method for water removal, involving the use of two parallel filters charged with silica gel. The sample stream is passed through one while the other is being regenerated. Most of the water must be removed by a rough means before using the filters. The danger in this method is that absorption of various sample components can occur; check for this carefully.

Sample Vaporization

If it is necessary to vaporize a liquid sample for analysis, commercial vaporizers can be purchased. However, if the sample is at a high pressure, it may be passed through a series of orifices to vaporize it.

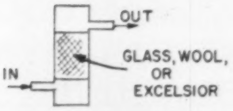


FIG. 3. PARTICULATE filter.

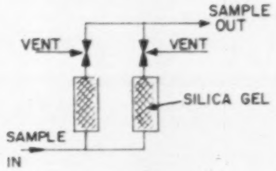
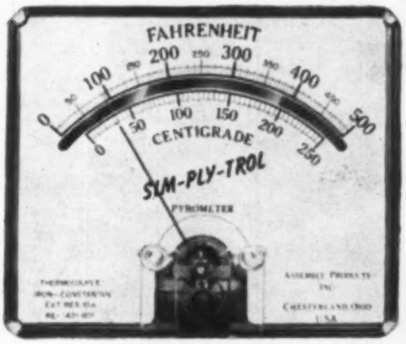


FIG. 4. DRIER.

To avoid erroneous analysis it is necessary to prevent sample condensation in a vaporized liquid sample. It is equally necessary to remove other condensation to prevent change in analyzer calibration and sensitivity. Commercial sample vaporizers are now available to assist in this problem.

These general rules will enable one to design a workable sample system for any analyzer. Others may prefer to use the experience of analyzer manufacturers and purchase packaged system. If so, these general principles should help one review any design he might purchase.



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are medium-resistance D'Arsonval meters with automatic, bimetal, cold-junction compensation, and copper-error correction. Standard accuracy is ± 2% (but ± 1% is available if you need it). Also standard are such niceties as an external 10-ohm resistor (to compensate for thermocouple resistance) that is adjustable, and mirror scales that avoid parallax reading errors. A.P.I. makes indicating pyrometers in 10 standard ranges (—200 to 3000°F.); 3 case types (clear plastic, black bakelite, ruggedized-sealed); and 6 sizes (2½" to 6"). All are surprisingly inexpensive. You'll have little trouble finding one that will fit your exact requirements for low-cost, accurate temperature indication.

Write for Bulletin 107

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A. S. T. M. BULLETIN D1588-58T
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SIMULATION COUNCIL

Newsletter

John H. McLeod Jr., EDITOR
Suzette McLeod, SECRETARY

8484 La Jolla Shores Drive,
La Jolla, California

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Bits

This month under Pieces your Newsletter offers summaries of talks given at the Eastern Simulation Council's February meeting (held at United Aircraft) by *Jack Andrews* on "General Applications for a Dynamic Storage Analog Computer"; *Max Gilliland* on "The Application of the Propagation Technique to the Solution of Elliptical Partial Differential Equations"; *Ronald Gocht* on "Operation of a Pulsed Analog Computer"; and *Jerry Kennedy* on "An All-Electronic Euhler Angle Transformation Computer."

These summaries are followed by some information on the March meeting of the Rocky Mountain SC at Littleton, Colorado, where *Charles Taylor* described the Martin-Denver analog facility and *George Miller* discussed hydrocarbon reservoir simulation.

Then mention is made of a talk, "An Analog Approach to the Solution of Non-linear Problems with the Number Series" by *C. H. Weaver*, given at the June meeting of the Southeastern Simulation Council at Auburn University, and two talks—a "Review of 1959 Work at Martin-Orlando" by *M. E. McCoy*, and "Pershing Flight Simulation" by *Walt Lee*, presented at the April meeting of the SSC at Martin-Orlando.

The first edition of the Rocky Mountain SC's "Tech Notes", a couple of Letters, and some unnecessary "Info" complete the October *Newsletter*.

Pieces

EASTERN S/C MEETING OF FEB. 1960 ON NEW TECHNIQUES IN SIMULATION

"On a cold, but beautiful, New England day in February," writes *William F. Blodgett*, Secretary-Treasurer of the Eastern Simulation Council, "the Eastern Simulation Council met at the home of the United Aircraft Corporation in East Hartford, Connecticut. Our host, Mr. *Ralph Belluardo*, had selected the topic of "New Techniques in Analog Simulation" for the meeting. As might be expected, what some people thought of as 'new techniques' was considered to be 'old hat' by others. Because of this the meeting turned out to be not only interesting, but quite lively in spots.

"I have attached to this letter a brief summary of the papers given at that meeting with the exception of the one given by Dr. Gilliland," the letter continues. "I have enclosed a copy of his paper."

As that is the only information your Ed has on the meeting we will pass on Bill's brief summaries just as we received them.

We will not, however, pass on Max Gilliland's complete 13-page paper as we received it because, although it may describe a technique which is very useful, it is primarily a mathematical rather than a simulation technique. Therefore we will only give you the author's own summary and suggest that if it sounds interesting, you write to Max for a copy.

Andrews on Dystac

"General Application for a Dynamic Storage Analog Computer" by *Jack Andrews* (Computer Systems, Inc., Monmouth Junction, N. J.) *

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*Jack presented similar material at the 1960 WJCC in San Francisco under the title "Mathematical Applications of the Dynamic Storage Analog Computer". Reprints are available from Computer Systems Inc., Culver Road, Monmouth Junction, New Jersey. See also *I&CS*, Sept., 1960.

Jack's paper stated basically that the high-speed switching characteristics of DYSTAC (Dynamic Storage Analog Computer) amplifiers readily lend themselves to development of memory circuits. He said that these memory circuits are invaluable in the solution of sequential calculations such as those encountered in the algebraic plate-to-plate equations for distillation, difference-differential equations, transient performance, partial differential equations, multiple integrals and operations research. It was said that the solution of problems heretofore unsolvable was made possible through the use of this equipment.

Both *Max Gilliland*, Advanced Study Programs Manager, of the Berkeley Computation Center, Los Angeles, and *Art Rubin*, Head of EAI's Princeton Computation Center, Princeton, pointed out that much valuable work had already been done in the solution of these types of calculations using other techniques over the past three or four years. Specific reference was made to the work done by *Roger Franks*, E. I. DuPont de Nemours Company in Newark, Delaware. The meeting became quite lively at this point.

Gilliland on Propagation Techniques for Solving Elliptical Partial Differentials

The next paper was:

"The Application of the Propagation Technique to the Solution of Elliptical Partial Differential Equations" by Dr. *Max Gilliland*, Beckman/Berkeley Division.

The author's own summary reads as follows:

"An alternative approach to the solution of elliptic equations has been presented. In some cases, this approach leads to new results; in others, to solutions normally obtained from separation of variables, or by standard integral representation. The propagation approach is based on finding a propagation operator. Solutions obtained in this manner are explicit in contrast with techniques such as relaxation or numerical integration. For unbounded regions, it is frequently easier to solve the problem using the propagation technique. The approximations to the propagation technique have been discussed along with the inherent difficulties."

Gocht on Pulsed Analog Computers

"Operation of a Pulsed Analog Computer" by *Ronald Gocht* (United Aircraft Corp., Research Laboratories, East Hartford, Conn.) followed.

Ron's paper pointed out that through the use of digital pulse programming and analog sample and storage gates, it is possible with one each of the various computing components, plus the required number of integrators, to solve an analog computing problem of any size. With the exception of integrators this would reduce tremendously the amount of analog components required in any analog-computing facility. The computer would also have a feature (which may or may not be considered to be an advantage) of not requiring a patch panel since all the programming can be done digitally.

Such a computer would probably be comparatively expensive because of the digital pulse programming and analog gates required. The computer's programming would undoubtedly be more complex and require more time than standard general-purpose analog-computer programming.

This paper was based on a master thesis, MIT, May 1958 by Mr. *R. C. Lee*, entitled "Logical Design of a High-speed Analog-Digital Computer for Simulation."

Kennedy on Euhler-Angle Transformation

"An All-Electronic Euhler Angle Transformation Computer" by *Jerome D. Kennedy* (EAI, Long Branch, N. J.), was the next paper.

Jerry's paper described a newly developed self-contained, all-electronic unit capable of generating a direction cosine matrix for converting a set of three orthogonal vectors specified in a rotating axis frame to three new vectors described in a reference frame for any of the six successive Euhler-Angle sequences. The nine input signals are three angular rates for the rotating frame; three initial Euhler Angles; and three orthogonal vector amplitudes in the rotating frame. The 24 output signals are three computed Euhler Angles and their corresponding angular rates; sines and cosines of each Euhler Angle; the nine elements of the direction cosine matrix; and the three converted vector amplitudes in the reference frame.

A solid-state sine-cosine function generator with low static error (no greater than 25 millivolts) and wide bandwidth was developed for use in these units. This made possible analog computing accuracies for this computation which had not before been obtainable.

Several of these units are in use at the general-purpose analog-computing facility at White Sands Proving Ground.

ROCKY MOUNTAIN S/C MEETING OF 17 MARCH

Maughan S. Mason (Thiokol Chemical Corp., Brigham City, Utah) sent us the following information on the second meeting of the Rocky Mountain Simulation Council, held on 17 March of this year in Littleton, Colorado, which had an attendance of 34.

The group visited the Glenn L. Martin analog facility and the combined computer laboratory at Ohio Oil. Following this, *Charles Taylor* described the Martin facility, which consists of eight consoles totalling about 400 amplifiers. Each console contains two resolver servos, two five-cup servo-multipliers, and three diode quarter-square multipliers, and three diode quarter-square multipliers, while in addition there are six time-recorders, four small x-y plotters, and two large plotting boards. The problems most often simulated are trajectory, point stability, and load studies, with some work on sampled data systems incorporating transport lags and quantization. Mr. Taylor also discussed certain techniques for scaling optimization.

Miller on Reserve Simulation

Dr. *George B. Miller* (Ohio Oil) discussed hydrocarbon reservoir simulation, using an analog computer. Despite the lack of information concerning the physical makeup of underground reservoirs, Ohio Oil has been able to simulate pressure and flow functions for given wells, and to use these to forecast future behavior, allowing flow to be regulated to provide optimum production. Dr. Miller said that predictions have thus far proved substantially correct. One of the greatest problems has been drifting diode function-generators in feedback circuits. After numerical factors are determined using the analog computer, the data are programmed for digital solution. Production data can thus be obtained digitally at any later time.

SOUTHEASTERN S/C MEETING OF 17 JUNE ON NONLINEAR PROBLEMS

And we are indebted to *James Tootle* (Martin Co., Orlando, Fla.) Secretary of the Southeastern Simulation Council, for the following summary of a talk "An Analog Approach to the Solution of Nonlinear Problems with the Number Series" given by *C. H. Weaver*, Westinghouse Professor of Electrical Engineering, Auburn University, Auburn, Ala. on June 17th.

"The basic procedures of number series calculation were reviewed, and the analog technique of Powell[*] presented in condensed form. The analog method was then extended to nonlinear differential equations of the type that requires multiplication, division, squaring, and the extraction of roots in their analogs. It was shown that number series operations are adapted to this type of analog work."

SOUTHEASTERN S/C MEETING OF 1 APRIL AT MARTIN-ORLANDO

At a meeting of the SSC, held on the first of April (no foolin'!) at the Martin plant, *M. E. McCoy* gave a "Review of 1959 Work at Martin-Orlando. Jim sends us the following summary:

1. Important facts: Problems originate outside the lab; analog personnel are responsible for verification, programming, and computer operation in cooperation with problem originator.

2. The number of problems completed during 1959 was 46: 33 were one-subsystem problems (60 amplifiers or less), of which 20 (61%) were run in five days or less, and one was run for a 77-day period;

There were 11 two-subsystem problems (60 to 120 amplifiers), of which one was run for 70 days, and eight were on from 5 to 50 days; and there were two larger problems (125-180 amplifiers), of which one was on the computer 33 days, and one was on for 96 days.

Sixty percent of the year was spent on eight problems, and seven of these required either two or three subsystems.

Although 33 single-subsystem problems were run, this was only about half of those requested. A small problem (quick access—short run) work load was not being served.

3. A description of some good and some not-so-good work was given. Good work was done in measuring open-loop frequency responses of control loops and flight sequencing control phase transition check with actual missile system operation. Not-so-good work done on a pulse-communication problem and an electronic countermeasures problem, which showed that more interested engineers[**], more R&D money, and more computer time were needed.

4. Some facts learned about Computer Operation:

There is no substitute for the best maintenance personnel.

Preventive maintenance should be scheduled.

The computer should be left on all the time.

Lee and Copes on Pershing Flight Simulation

Walt Lee and *Ed Copes* (both of the Martin Co., Orlando) talked on "Pershing Flight Simulation" at the same April meeting, and *Jim Tootle* has sent us this summary:

"Complete flight simulation provides a powerful tool in the design of a missile system. A pitch-plane, three-degree-of-freedom trajectory of a two-stage ballistic missile was simulated in this study. Missile kinematics, space geometry, and a complete guidance and control system were simulated on the analog computer. Actual missile hardware (including gyros, control computer, actuators, and control vanes) was inserted into the loop during a portion of the test.

"Objectives of the test were to confirm suitability of control and guidance gains, predict guidance and control performance, and provide a system test of the complete missile.

"The analog simulation occupied three substations of the Goodyear A-14 Computer, and used 165 operational amplifiers, 12 diode function generators, 27 electronic and three servo multiplications, five resolutions, and one inverse resolution. Interconnection between the three computer substations, the three-axis flight-simulation table, and the remotely located missile-mounted control hardware was provided (through a distance of some 180 feet) by nearly two miles of shielded cable.

"Missile gyros, mounted on the three-axis flight-simulation table, sensed attitude angle of the table as commanded by the analog computer, then passed their information to the missile-mounted control computer, which in turn positioned the control surfaces to provide the required corrective action. Potentiometers were used to sense control surface positions and feed back to the analog model voltages representing surface deflection.

"Computer runs consisted of a complete powered trajectory—from lift-off to burn-out. Environmental parameters and missile parameters were varied by a specified amount to obtain the effects of various tolerances on system performance. A point-mass digital trajectory program was used to check primary trajectory parameters.

"Subsequent flight tests revealed good correlation between the predicted system stability and performance and actual missile performance."

Auto-Set and Auto-Control Systems are needed for large problems, but must be reliable and well maintained.

More small problems can be handled when paper work, programming, and checking are minimized.

5. Some circuits were presented, and the engineers using the circuits were introduced to answer the questions about pulse generation circuits, a beam analog for vibration studies, and a lab-built Function Generator.

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[*] "Digital Computer Solution of Differential Equations by Number Series", Homer M. Powell, Master's Thesis, University of Tennessee, 1958.

[**] More engineers, or more interest? —Ed.

Something New!

This month your *Newsletter* brings you the Rocky Mountain Simulation Council *Tech Notes*. If they continue to send them to us *and the response from you is favorable*, this can become a regular feature of the *Newsletter*, giving the contributors the national distribution they seek. (As *I&CS* now reaches more than 40,000 readers, this is true "national distribution.") Similar material from other organizations and individuals is invited.

There are many ideas, circuits, and notes on simulation techniques which are not singly worthy of presentation as technical papers, but which are nevertheless quite useful. At the 24 June meeting of the Rocky Mountain Simulation Council it was decided to gather these items and publish them, hoping the response would be sufficiently great that either Simulation Councils, Inc. or one of the computer manufacturers would assume distribution on a national scale. The first group is given below. The contributors will be shown wherever possible to allow interested persons to obtain additional information. Comments and further ideas should be sent to *Maughan S. Mason*, Computation Division 71-D, Thiokol Chemical Corporation, Brigham City, Utah.

ROCKY MOUNTAIN S/C TECH NOTES

1. Use of Initial-Condition Networks for Additional Summer Inputs

When a combination summer-integrator is used in the integrate mode, the feedback resistor is usually available as an additional 1-meg input. *Ed Massell* and *Robert Wieneke* of EAI have pointed out that, at least for EAI equipment, the IC relay may be held closed (by applying relay voltage to the coil of the particular amplifier), which connects a 0.1-meg resistor in the feedback. Then the normal 10-gain inputs and the IC input become gains of one, while the 1-meg inputs and the feedback resistor become 1/10-gain inputs, a total of eight inputs in place of the normal six.

2. Voltage Hold Through Time-Scale Change (M. S. Mason and W. R. Lym, Thiokol)

It would sometimes be useful to have the capability of changing time scale in the middle of a problem run. This would be practical if the time-scale circuit were modified as shown in Fig. 1. Tests indicate no apparent shortcomings except the need for additional relay contacts. Another modification to the time-scale change, providing greater flexibility, allows portions of the time scale change to be activated independently. CSI does this by providing independent control of all four patchboard quadrants. EAI splits the integrators into groups of 20 and 10 each, allowing considerable flexibility if one wishes to open the oven to make changes. These changes could be made on the patchboard, in groups of perhaps five integrators, by providing the bottle-plug connections shown in Fig. 2. Connecting the "fast" hole to ground puts these five integrators to "fast time"; grounding the "slow" hole slows down the same five integrators, independently of all other integrators.

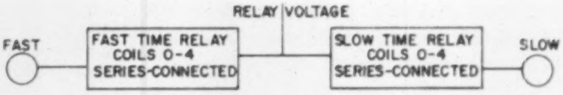
3. Fixed 1/10 Attenuator (White Sands Missile Range)

A 1/10 attenuation is obtained from the voltage divider network shown in Fig. 3, provided the "arm" is connected to a 1-meg load. The impedance of the attenuator is also 1-meg under these conditions, permitting series "stacking" of the units because each would provide a 1-meg load for the next. Uses would include attenuation directly from a servo multiplier while maintaining a 1-meg load on all cups, accurate 0.1000 potentiometer settings, etc. As an indication of accuracy, two attenuators in series for both input and feedback of a high-gain amplifier yielded an output of 100.00 ±0.01 volts when 100.00 volts was applied as an input (Fig. 4).

4. Mach No. From a Servo (M. S. Mason, Thiokol)

If a servo driven by altitude is being used in a simulation, it is possible to scale and bias the y input so that the center tap of the servo pot corresponds to the value of altitude at which the velocity of sound becomes constant ($\approx$50,000 feet). Then an approximation for Mach No. (for y up to 100,000 feet) can be obtained from either of the circuits shown in Fig. 5.

Fig. 2


RELAY VOLTAGE
FAST
FAST TIME RELAY COILS 0-4 SERIES-CONNECTED
SLOW TIME RELAY COILS 0-4 SERIES-CONNECTED
SLOW

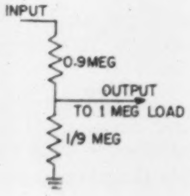


Fig. 3

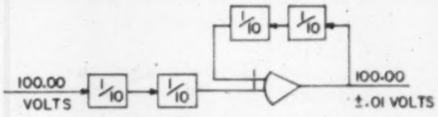


Fig. 4

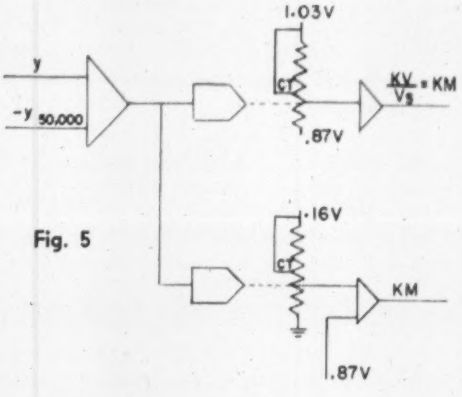


Fig. 5

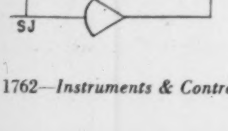


Fig. 1

Letters

Dear John:

Just a bit of news from the Midwestern Simulation Council. It seems that some of our people are moving around. *Bert Johnson*, our secretary, is now in Brussels, Belgium on a special assignment for Electronic Associates. We expect him back soon. *Bob Kohr*, Steering Committee member, is leaving General Motors Research to go to Purdue University this fall where he will teach. *P. J. Hermann*, Steering Committee Vice Chairman, is leaving Goodyear Aircraft to go to Ohio State University to teach Aeronautical Engineering; just call him professor. Goodyear Aircraft won't seem quite the same without P. J. He will be with us next year as Chairman of the Steering Committee.*

Our meetings have been moving along very well this year with good attendances and we feel a good variety of topics. Our next meeting will be October 10, at Charleston, West Virginia on "Process Control." This will be a joint meeting with the Eastern Simulation Council. *P. J. Hermann* will send you a report of the last meeting.

R. J. King
Division Manager
Research Department
Caterpillar Tractor Co.
Peoria, Ill.

---

*Confirmed by another letter from P. J.

Dear Mr. McLeod:

I am enclosing a recruiting bulletin for a GS-13* position in the Simulation and Computer Center at the U.S. Naval Ordnance Test Station, Pasadena.

We have been attempting to fill this position for several months and have been unsuccessful. It occurred to me that you might possibly know of someone who is qualified and looking for a new position. If so, I would appreciate your passing this information on. Although we are requesting a degree in electrical engineering or physics, a mathematics degree with the appropriate experience would be satisfactory. The position is basically one of system analysis and direction of the simulation programs in our center. At the present time, the majority of our equipment is analog (approximately 600 amplifiers). We expect to incorporate a medium-size, very high-speed digital computer into the simulation facility within the next year.

If you have an opportunity to stop by at anytime, I would be happy to show our simulation facility to you.

L. Z. Maudlin
Head, Simulation and Computer Center Guidance and Control Division
U.S. Naval Ordnance Test Station
Pasadena 8, Calif.

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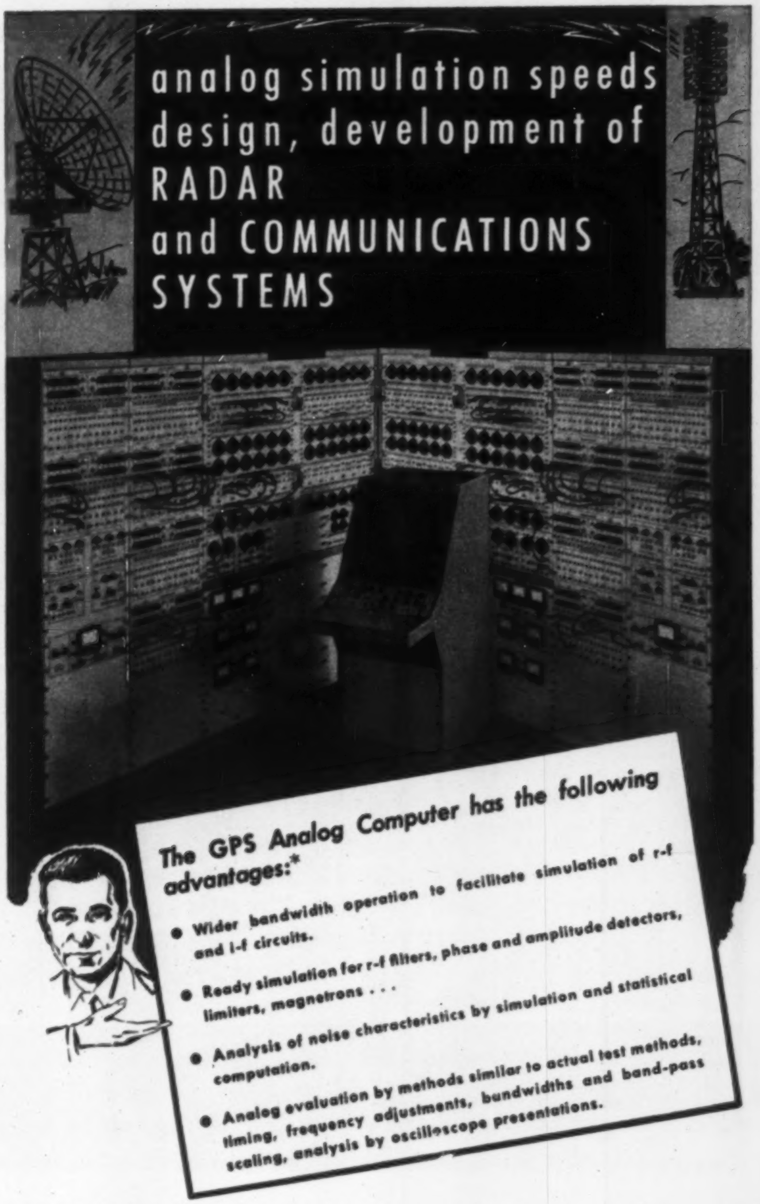
*10,635 per annum



The GPS Analog Computer has the following advantages:*

- **Wider bandwidth operation to facilitate simulation of r-f and i-f circuits.**
- **Ready simulation for r-f filters, phase and amplitude detectors, limiters, magnetrons . . .**
- **Analysis of noise characteristics by simulation and statistical computation.**
- **Analog evaluation by methods similar to actual test methods, timing, frequency adjustments, bandwidths and band-pass scaling, analysis by oscilloscope presentations.**

The GPS Analog Computer is a compressed-time-scale computer operating with an integrator sensitivity of 3000 volts per second per volt. Because of its wide band width operation, the frequency range of simulation of the GPS Computer is several orders wider than that of conventional slow-speed computers.

*The Defense Systems Department of General Electric, Syracuse, N. Y. selected the GPS Computer for their communication and radar optimization studies. By using analog techniques they propose to save considerable time and money by combining and compressing the stages of the development cycle.

ENGINEERS: A man of talent and ambition can find greater satisfaction in a small company. Investigate opportunities available now at GPS in sales, applications and development engineering.

GPS INSTRUMENT CO., Inc.

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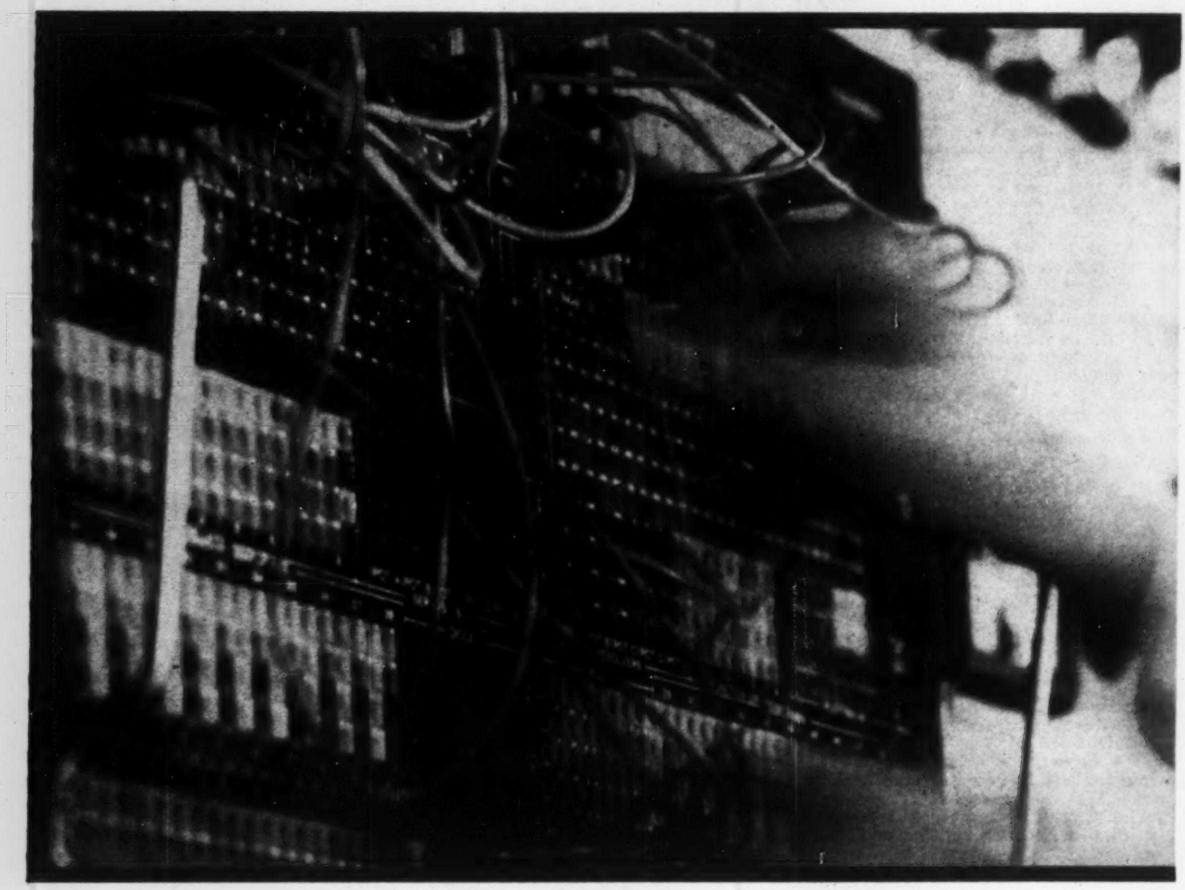
CIRCLE 78 ON READER-SERVICE CARD

DYSTAC*



A MAJOR BREAKTHROUGH IN PROBLEM SOLVING

*DYSTAC: Dynamic Storage Analog Computer, developed by CSI, incorporates high-speed repetitive capabilities with dynamic storage of analog data to an accuracy of 0.01% and with a time-base accuracy of ±0.5 microsecond. This development has tremendously increased the versatility, economy, and speed of solution associated with analog computers.

DYSTAC provides unique time-sharing of computer components and high speed reiterations. These features make possible economic and rapid solution of complex problems that have required too many computer components or too long a solution time to be considered practical for either digital or analog techniques. Different combinations of this new development readily solve problems in four broad categories.

- Sequential calculation, as encountered in the distillation problem. Here, successive solutions to algebraic matrices are obtained from cycle to cycle at a repetitive speed of 60 cps until the problem is solved.
- Definite integral calculations. Varying definite integrals are evaluated from one cycle to another and held in memory for the successful solution of optimization problems.
- Rapid evaluation of multiple integrals. This technique can be employed for the solution of partial differential equations.
- Transient problems and difference-differential equations are solved with continuous memory.

For complete information or to arrange for a demonstration write, phone, or wire:

COMPUTER SYSTEMS, INC., Culver Road, Monmouth Junction, N. J. • DAvis 9-2351

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CIRCLE 79 ON READER-SERVICE CARD

INFORMATION (Without Theory)

The amount of information your Ed found it possible to pass on to you just as received from Blodgett. Mason, and Tootle made the job of "editing" this month's *Newsletter* comparatively easy. However, lest our readers think it is always thus we give you below a sample of the kind of material we often have to work with:

"Was any work done on the adaptive stability of the adaptive loop itself? But I have been doing some work on computer variance of what I expect to get out of the multiplier when I am correlating, and this would give me an idea of how much time I would have to wait to be sure that I won't have the large volt correlation. And, this is about as far as anything has been done on the stability there. By putting in these limiters, we have found that in practice we could be sure that we would not have instability. We have never had a case of instability in this adaptive loop, where we did have these limiters. Although we are out of it, we tried out the gain, and we get as you saw this take-off in the wrong direction, and if you had it higher, it would take-off just further, and get out-of-hand. It is very complicated, although, the system itself with time varying, the adaptive loop is got everything bad in it that you want—it is non-linear, depends on the inputs, of course, it's time varying also, it's rough.

Any other questions?

The foregoing is typical of transcriptions made directly from a tape recording.

Your Ed has never claimed to be more than an imperfect filter, but when I work on 20 to 30 pages of material with a signal-to-noise ratio like that, searching for the signal—if any—I feel that I have earned my keep!

A meeting is being planned on combined simulation, to be held in Philadelphia immediately following the Eastern Joint Computer Conference in New York in December. Will anyone desiring to present a paper at this meeting drop a note to your Ed. to that effect, giving title and a brief description of the area to be covered?

Computer Events

★ **Eastern Simulation Council**
Midwestern Simulation Council
Joint meeting on Process Control
Union Carbide Olefins Company
Charleston, West Virginia
10 October 1960

AIEE-IRE-ISA
Electrical Techniques in Medicine and Biology Conference
Sheraton-Park Hotel
Washington, D. C.
31 October—2 November 1960

★ **AIEE**
Power Industry Computer Applications Conference
Chase Hotel
St. Louis, Missouri
9-11 November 1960

★ **IRE-PGME**
"The Nervous System Components vs. Computer Components
A. S. Hoagland (IBM); K. Killam (Stanford Medical School); C. Rosen (Stanford Research Institute)
San Francisco, California
24 November 1960

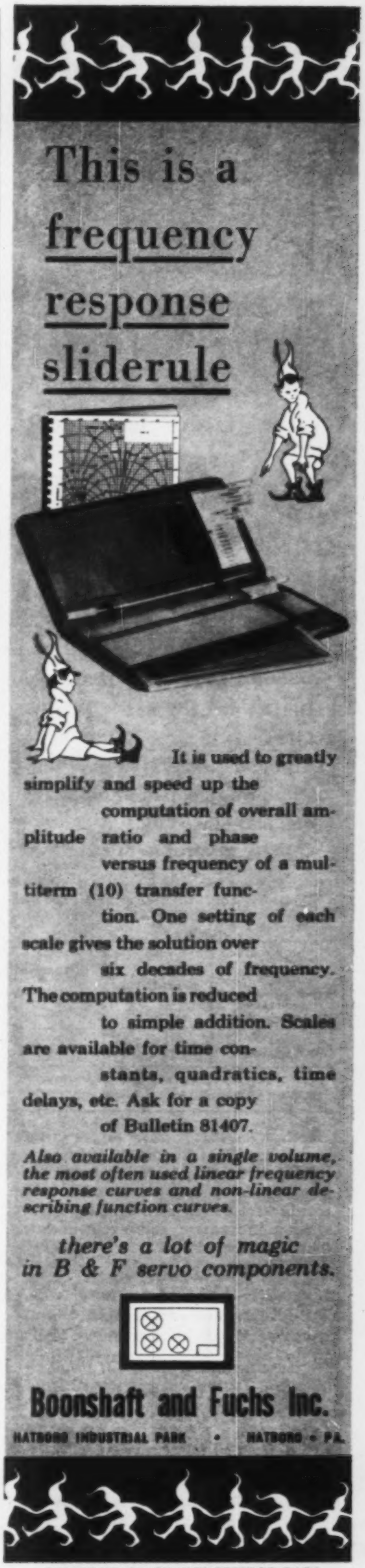
IRE-PGME
"Computer Study of the Nervous System"
W. Clark (MIT Lincoln Laboratories)
Lexington, Massachusetts
8 December 1960

★ **AIEE-IRE-ACM**
Eastern Joint Computer Conference
Hotel New Yorker
New York, N. Y.
13-15 December 1960

★ **Combined Analog-Digital Computer Systems Symposium**
Sponsored by Simulation Councils, Inc., and Missile and Space Vehicle Dept. General Electric, Phila, 1, Pa.
Sheraton Hotel, Phila., Pa.
December 16, 17, 1960 (following EJCC on Dec. 13-15)

★ **IRE-PGME**
"Studies on Use of Computer in Medical Practice and Research"
C. J. Roach and Panel, MEDIC SYSTEM Development Company
San Francisco, Calif.
19 April 1960

★ **AIEE-IRE-ACM**
Western Joint Computer Conference
Ambassador Hotel
Los Angeles, California
9-11 May 1961


This is a frequency response sliderule

It is used to greatly simplify and speed up the computation of overall amplitude ratio and phase versus frequency of a multiterm (10) transfer function. One setting of each scale gives the solution over six decades of frequency. The computation is reduced to simple addition. Scales are available for time constants, quadratics, time delays, etc. Ask for a copy of Bulletin 81407.

Also available in a single volume, the most often used linear frequency response curves and non-linear describing function curves.

there's a lot of magic in B & F servo components.

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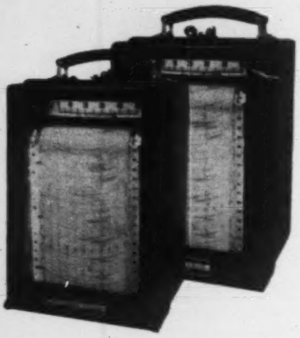
Mighty Useful



E-A Recording

DC MILLIAMMETERS

DC MICROAMMETERS

For a thousand and one uses in every field of research and production of which the following are typical:

- **Performance tests**
- **Life tests**
- **Tracer element studies**
- **Photronic measurements**
- **Medical electronics**
- **Quality control in production**

On some of the above, the recorder is used direct. On others it operates in conjunction with additional equipment.

DC Range	Approximate Input Resistance	Response
0-50 (A) Microamperes	200 ohms	1 sec.
0-1 Milliamperes	1400 ohms	½ sec. (B)

(A) Power required: 120 volts, 60 cycles.
(B) With 50,000 ohms in external circuit.

Here's a versatile team of direct writing instruments that combines extreme sensitivity with simplicity of design and ruggedness of construction for long, trouble-free life. The simple, direct-writing movement eliminates maintenance associated with servo or linkage driven systems.

Like all E-A recording meters, E-A Milliammeters and E-A Microammeters are guaranteed for two years.

Send for Catalog Sections 41 and 42

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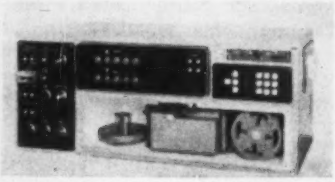
CIRCLE 81 ON READER-SERVICE CARD

ICS NEW INSTRUMENTS

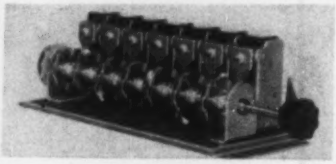
POSITIONING CONTROL

New Model 600 Numerical Positioning Control for point-to-point positioning of machine elements uses absolute decimal digital control that employs no binary or analog circuitry. Control accuracy is: Increments of 0.001"; repeat to 0.0002" dependent upon application.—*Carlton Controls Corp., 15 Sagamore Rd., Worcester 5, Mass.*



CIRCLE 207 ON READER-SERVICE CARD

SELECTOR SWITCH



New 12-position Rotary Selector Switch, Series SS, features: 10-amp contact rating for each circuit; each unit provided with a dial and position indicator; spring-loaded position control; etc.—*Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J.*

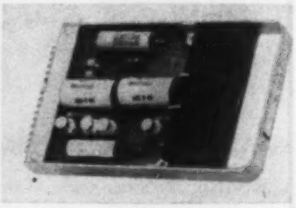
CIRCLE 208 ON READER-SERVICE CARD

DATA TRANSMISSION UNIT

New 1009 Data Transmission Unit links the magnetic-core memories of solid-state IBM 1401 computers over regular local or long distance telephone and telegraph lines. It enables two-way communication between computers at the rate of 150 numbers or letters a second. While information is being transmitted and received, both 1401 systems are free to perform simultaneous tape-to-printer operations. —*International Business Machines Corp., Data Processing Div., 112 East Post Rd., White Plains, N. Y.*

CIRCLE 209 ON READER-SERVICE CARD

DC POWER SUPPLY

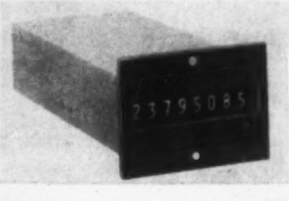


New self-contained Regulated Power Supply, Model S-94002-PD, can be used for outputs from 10 to 35 v dc with a continuous current of 0 to 0.5 amp. Line and load regulation is better than ±0.75%.—*Plug-In Instruments, Inc., 1416 Lebanon Rd., Nashville, Tenn.*

CIRCLE 210 ON READER-SERVICE CARD

ELECTRIC IMPULSE COUNTER

New Sodeco 7- and 8-digit Totalizing Electric Impulse Counters, Types TCe7E and TCe8E, respectively, have the same dimensions (1.653" x 1.220" x 4.370"), and are suitable for flush mounting. Counters are available in two counting speeds.—25 impulses/sec. and 10 impulses/sec.—*Landis & Gyr, Inc., 45 West 45th St., New York 36, N. Y.*



CIRCLE 211 ON READER-SERVICE CARD

FOR FURTHER INFORMATION USE CARD ON PAGE 1819

200 POINT RECORDER

New Dynamaster Multiple-Bank Recorder records, up to 200 separate variables on a 12-inch strip-chart. Features include: lights which indicate the bank and point being recorded; switches for eliminating any bank (or banks) from the scanning sequence (speeding operation); and selector switches for automatic or manually advanced scanning or single-point recording.—*Bristol Co., Waterbury 20, Conn.*

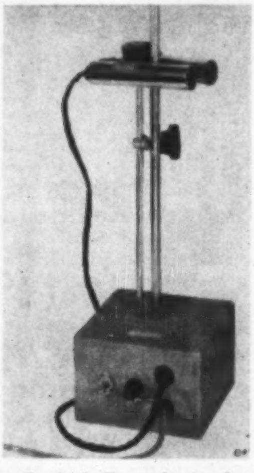
CIRCLE 212 ON READER-SERVICE CARD

CLOSED-CIRCUIT TV

New line of EMI Electronics, Ltd., closed-circuit television equipments includes all elements needed for remote control and industrial and research applications—microscopic, infrared, ultraviolet, etc.—*Fairbanks, Morse & Co., Electronics Div., 505 Oakwood Ave., West Hartford* 1, *Conn.*

CIRCLE 213 ON READER-SERVICE CARD

OPTICAL TRANSDUCER



New Optical Transducer for fhp-motor testing furnishes stable electrical pulses proportional to rotational velocity, and serves as an input source for decade counters and other pulse-operated tachometers. Primary advantages are extreme sensitivity without amplification and nearly flat response over a wide frequency range.—*John Chatillon & Sons,* 85 *Cliff St., New York* 38, *N. Y.*

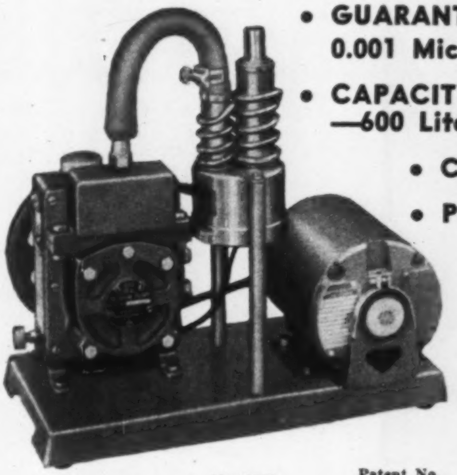
CIRCLE 214 ON READER-SERVICE CARD

MATCHED PERFORMANCE HIGH VACUUM

Welch Duo-Seal® Mechanical and Diffusion Pump Assembly

EACH ELEMENT WITH TWO-STAGE CONSTRUCTION
WATER-COOLED OR AIR-COOLED MODELS

- **GUARANTEED VACUUM— 0.001 Micron** (0.000 001 mm Hg)
- **CAPACITY AT 0.1 MICRON —600 Liters Per Minute**
- **CONVENIENT**
- **PORTABLE**



No. 1392 Patent No. 2337849

$300.00
Complete with Motor

Assembly consists of an unbreakable diffusion pump unit, employing a two-stage mechanical pump. Complete with oil for both pumping units.

- ECONOMICAL TO RUN AND MAINTAIN • QUIET OPERATION

1392. MECHANICAL AND DIFFUSION PUMP, Water-Cooled
For 115 Volts, 60 Cycles, A.C. **Each, $300.00**

1392A. MECHANICAL AND DIFFUSION PUMP, Air Cooled.
For 115 Volts, 60 Cycles, A.C. **Each, $300.00**
For attached Belt Guard, add $15.00 to above prices.

1391. DIFFUSION PUMP, Only, Water Cooled, With Octoil. Each, $160.00

1394. DIFFUSION PUMP, Only, Air Cooled With Octoil. Each, $160.00

1393. MOUNTING PARTS.
For mounting No. 1391 or No. 1394 Diffusion Pump on base of mechanical pump. **Set, $3.00**

Other combinations are available with speeds of up to 16,500 liters per min at 0.1 micron. We will gladly submit full details describing the best combination for your particular application.

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CONTROL

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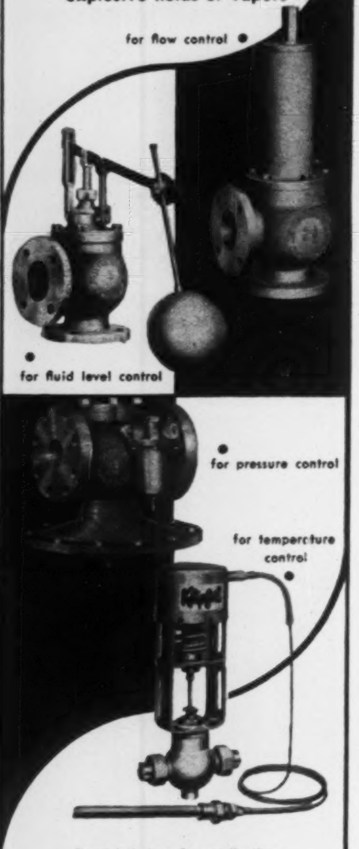
of

STEAM • GAS • AIR • WATER

viscous or abrasive sludges

CHEMICALS

explosive fluids or vapors



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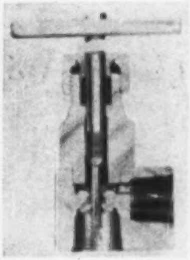
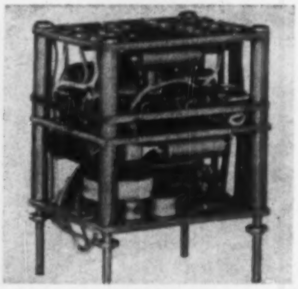
MICRO-FLOW VALVE



New type Micro-Flow Valve for the control of ultra-small amounts of liquid or gas allows C_V's of 0.002 to zero to be controlled linearly over a stem travel of ⅝". At 5000 psig the valve can be throttled from 3 ccpm to 5 gpm. At lower pressures the valve has been used to deliver as little as 10 drops/hr.—*General-American Valve Co., Box 444, Corona Del Mar, Calif.*

CIRCLE 215 ON READER-SERVICE CARD

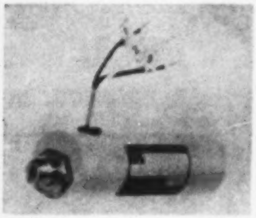
MODULAR PHASE CONTROLLERS



New line of solid-state, modular, SCR Phase Controllers and Servo Amplifiers uses the new silicon-controlled rectifiers (SCR's) which can be combined to provide optimum design for practically any power-control application from watts to kilowatts providing a sharp pulse or gating signal which turns on the SCR units. The firing angle of the SCR is a function of the input signal and thus proportional control of the a-c power is provided.—*General Electronic Control, Inc.*, 1015 *South Sixth St., Minneapolis* 4, *Minn.*

CIRCLE 216 ON READER-SERVICE CARD

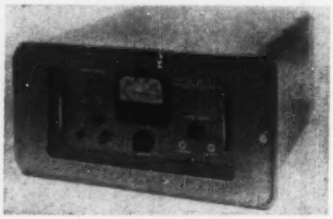
HI-PRESS TRANSDUCERS



New miniature, one-inch dia. Pressure Transducers, Series 8416, capable of measuring up to 15,000 psig, and weighing less than 0.25 lb, feature a twisted tube as presure sensing element. Can measure gage, absolute, or differential pressures with the linearity held within a maximum tolerance of 1.5% over the entire range.—*Colvin Labs.,* 364 *Glenwood Ave., East Orange, N. J.*

CIRCLE 217 ON READER-SERVICE CARD

METAL DETECTOR



New Metal Detector, Model 200A, which locates small ferrous or nonferrous tramp-metal particles in nonmetallic materials, features reliable, stable, unattended operation even during changes in temperature, humidity, and barometric pressure, and in the presence of smoke and noxious fumes.—*Electro-Mechanical Research, Inc., Sarasota, Fla.*

CIRCLE 218 ON READER-SERVICE CARD

INSTRUMENT PLUG VALVES

New line of Tufline Instrument Plug Valves, rated for 300# ASA service, with screwed ends, features Teflon sleeves and a unique element in the valve design, a sculptured interior body bore from bar stock metal. Available in sizes ¼" through 1". —*Continental Mfg. Co.,* 230 *Park Ave., New York* 17, *New York.*

CIRCLE 219 ON READER-SERVICE CARD

Remove all traces of OIL from compressed air lines . . . NEW WILKERSON

"WHIRLFLO"

For air lines ¼" to 5" P.T. with or without pipe flanges.

Exclusive features of NEW Wilkerson "WHIRLFLO" FILTER

- ★ Metal bowl or transparent bowl.
- ★ "Micro-Pruf" cartridge completely removes oil and particles as small as 3 microns—lasts 4 times longer.
- ★ 200% greater CFM capacity. Maximum pressure 250 PSI with metal bowl.

Put the "WHIRLFLO'S" double-barreled action to work for you.

1. Centrifugal force from special baffle vane sends contaminants to walls of cylinder AWAY from cartridge, from where they drain into sump.
2. Then seperated air flows through "Micro-Pruf" cartridge. This 2-stage action cleans better and adds months of life to cartridge.

SAVE on maintenance and operation.

1. The cartridge lasts 4 times longer than others.
2. Cartridge is easily replaced by removing one nut while unit remains on pipe line.
3. Addition of automatic petcock eliminates human failure to drain, keeping cartridge from water level.

WRITE TODAY FOR COMPLETE INFORMATION ON THE EFFICIENT, MONEY-SAVING WILKERSON "WHIRLFLO", DESIGNED FOR INSTRUMENT PROTECTION.

WILKERSON CORPORATION

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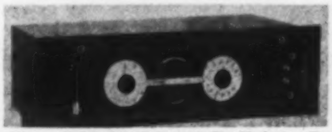
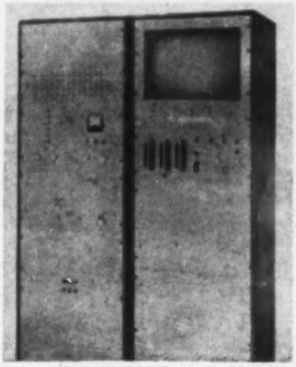
KELVIN RATIO BRIDGE



New ESI Model 240-R Kelvin Ratio Bridge compares an unknown resistor to a standard resistor. A bridge deviation dial reads the difference between the two resistors in either % or ppm. The range dial permits comparison of resistors in the ratio of 10:1 or 100:1. Multiplier ratios are 0.01, 0.1, 1, 10 and 100. Accuracy is ± 0.005% on 1:1 range, ± 0.01% on other ranges.—*Electro Scientific Industries, Inc.*, 7524 *S. W. Macadam Ave., Portland* 19, *Ore.*

CIRCLE 220 ON READER-SERVICE CARD

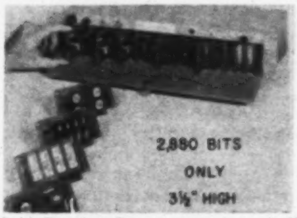
ELECTROSTATIC STORAGE



New Model MSS-100 Multitrace Electrostatic Storage System accumulates repetitive or non-repetitive analog data and provides a continuous visual read-out. System utilizes a high-resolution tube to simultaneously store up to 28 channels of low and high-speed phenomena. Visual read-out is accomplished by means of a 17-inch TV-type video monitor.—*Electrodynamic Instrument Corp.*, 1841 *Old Spanish Trail, Houston* 25, *Tex.*

CIRCLE 221 ON READER-SERVICE CARD

BUFFER STORAGE



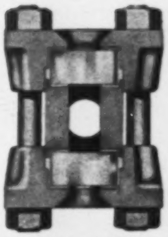
New Buffer Storage series of digital storage systems with storage capacities from 36 to 4032 characters uses magnetic logic techniques. System contains all functional circuits for addressing, writing, sensing, and output flip-flops. Details in bulletin. —*DI/AN Controls, Inc.*, 40 *Leon St., Boston* 15, *Mass.*

CIRCLE 222 ON READER-SERVICE CARD

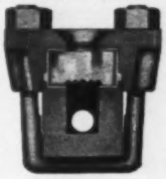
Strahman

HIGH PRESSURE GAUGES

USED IN REFINERIES AND CHEMICAL PLANTS THROUGHOUT THE WORLD



THRU VISION



REFLEX
Single or Multiple Sections

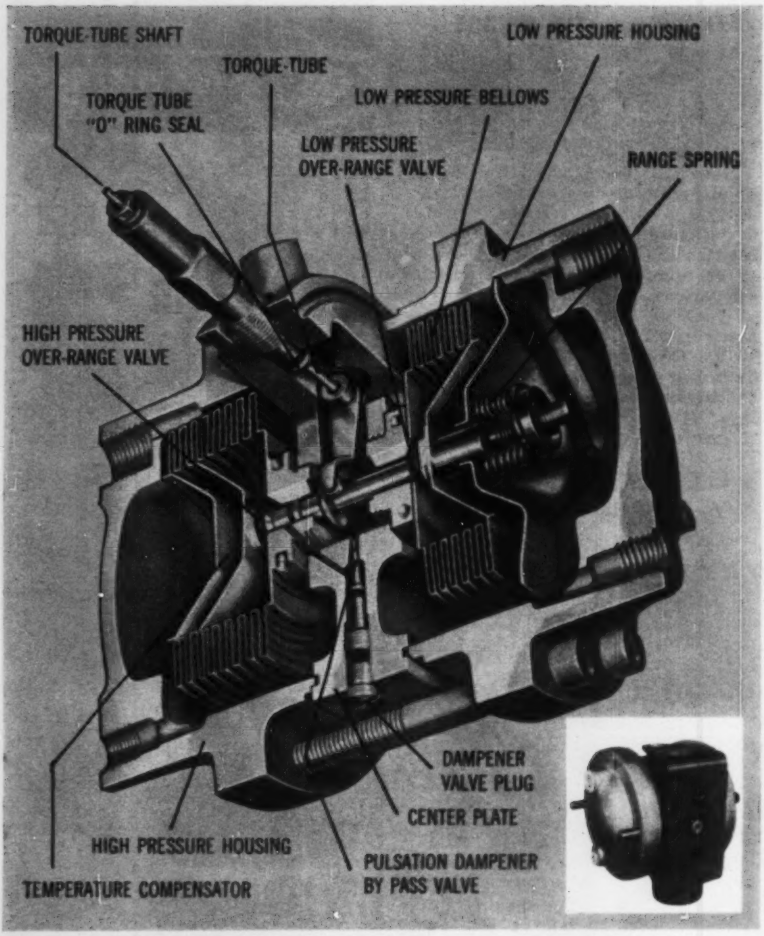
TUBULAR

Gauge Cocks
•
Large Chamber Reflex Gauges
•
Heated or Cooled Gauges

SEND FOR COMPLETE CATALOGUE

STRAHMAN VALVES, Inc.
NICOLET AVE., FLORHAM PARK, N. J.

CIRCLE 85 ON READER-SERVICE CARD


TORQUE-TUBE SHAFT
TORQUE-TUBE
TORQUE TUBE "O" RING SEAL
LOW PRESSURE HOUSING
LOW PRESSURE BELLOWS
LOW PRESSURE OVER-RANGE VALVE
RANGE SPRING
HIGH PRESSURE OVER-RANGE VALVE
DAMPENER VALVE PLUG
CENTER PLATE
HIGH PRESSURE HOUSING
PULSATION DAMPENER BY PASS VALVE
TEMPERATURE COMPENSATOR

DON'T WORRY ABOUT OVERRANGING THIS METER BODY

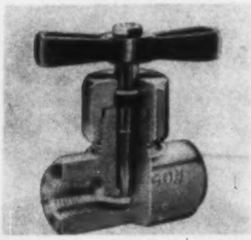
The exclusive Barton rupture-proof dual bellows meter is not affected by overranging, maintains calibration and requires minimum maintenance.

Built-in ability to withstand violent line surges, yet immediate response to the slightest differential pressure or level changes – that's the Barton rupture-proof 199 meter body. Proved in countless demanding installations, the 199 meter body is the heart of an entire line of precise instruments that includes controllers, indicators, recorders, integrators, transmitters and switches. The 199 meter body features such refinements as temperature compensation for maximum stability, adjustable pulsation dampener for positive response control, top and bottom pressure taps for self-draining and easy venting. The 199 is available in a full range of differential pressures up to 50 psi and static pressure ratings up to 6,000 psi. For the ultimate in dependability, accuracy and minimum maintenance, specify Barton.

BARTON®
INSTRUMENT CORPORATION
580 MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

CIRCLE 86 ON READER-SERVICE CARD

NEEDLE VALVE



New low-cost Series-5,000 Needle Valve, operation-rated for 10,000 psig, features design innovations which prevent the valve stem from blowing out or backing out under pressure. Safety factor is a minimum of 4:1 which meets or exceeds all published specification requirements and makes it adaptable to high pressure applications in oil field equipment, refineries, and on test and instrument panels.—*Dragon Engineering Co., Box 185, Norwalk, Calif.*

CIRCLE 223 ON READER-SERVICE CARD

DATA TAPE READER

New photoelectric Tape Reader is a basic element of the system for digital data acquisition, storage and reduction. It reads tapes from recorders and converts their information into electrical impulses directly usable by standard business machines and display devices. The electrical output drives a computer directly. Available in several basic forms it can be used alone or with accessory amplifiers.—*Advinco, 700 South Fourth St., Richmond, Calif.*

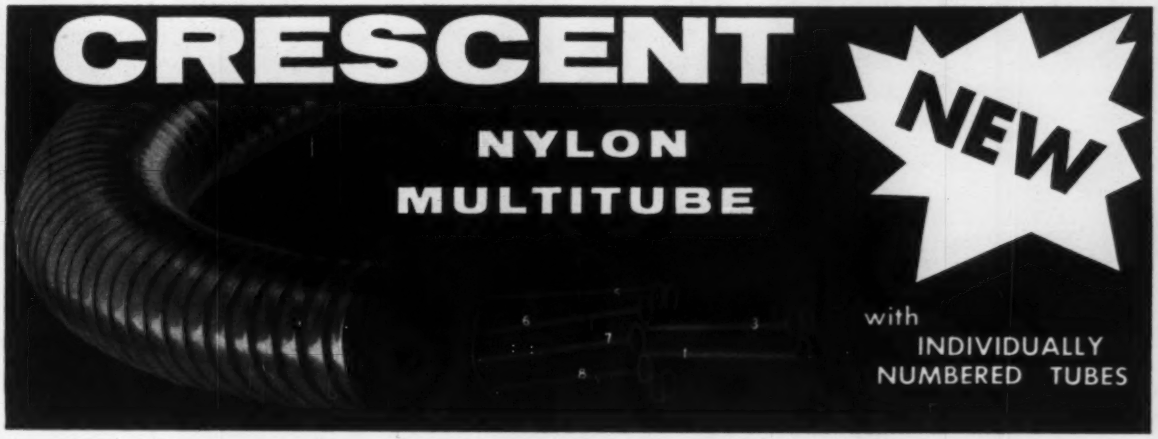
CIRCLE 224 ON READER-SERVICE CARD

STOPWATCH

HEUER
HOUR DECIMAL

New Decimal medium-duration Stopwatch, Model 33.224, features a black thin tailless hand which makes one complete cycle in 0.6 min (36 sec) and a concentric red inner hand which registers each complete revolution. Totalizing is up to 0.6000 hrs (2160 sec).—*Heuer Timer Corp., 441 Lexington Ave., New York 17, N. Y.*

CIRCLE 225 ON READER-SERVICE CARD



CRESCENT

NYLON MULTITUBE

with INDIVIDUALLY NUMBERED TUBES

NYLON TUBES: TOUGHER AND STRONGER THAN POLYETHYLENE TUBES COST LESS THAN COPPER TUBES

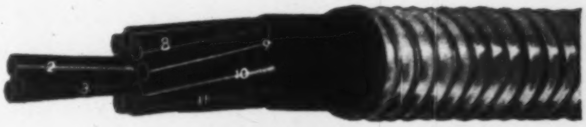
CRESCENT NYLON MULTITUBE employs SPIRALLY CABLED, long-length tubes of black pigmented, heat-stabilized nylon for maximum resistance to environmental deterioration. The SPIRALLY CABLED tubes permit maximum flexibility and bending with no distortion or stress on the tubing.

CRESCENT NYLON MULTITUBE permits greater working pressures and higher operating temperatures than those recommended for polyethylene tubing. The tubes have outstanding impact and abrasion resistance, coupled with unusually high fatigue resistance to flexural and vibrational stresses over a broad temperature range. The tubing is resistant to most chemicals and solvents.

CRESCENT NYLON MULTITUBE is available with 2 to 37 tubes, protected against mechanical injury by a flexible, interlocked, galvanized steel, aluminum or bronze armor. A polyvinyl chloride (PVC) sheath, or a combination of both can be furnished when additional corrosion protection is required. Each tube is individually numbered throughout the length for positive identification of all tubes at any point.

THREE STANDARD TYPES TO MEET YOUR SPECIFIC NEED

TYPE NA— Interlocked, galvanized steel armor provides complete mechanical protection to the inherently corrosion-resistant tubing. Also available with aluminum or bronze armor.



TYPE NAT— Polyvinyl chloride (PVC) sheath over the armor adds corrosion protection for the armor. Can be buried in the earth.

TYPE NT— PVC sheath gives limited mechanical protection. For use in troughs, trays or conduit.

CRESCENT NYLON PRECISION INSTRUMENT TUBING, TYPE N,

is also available in 100-foot coils in cartons and 500-foot lengths on spools.

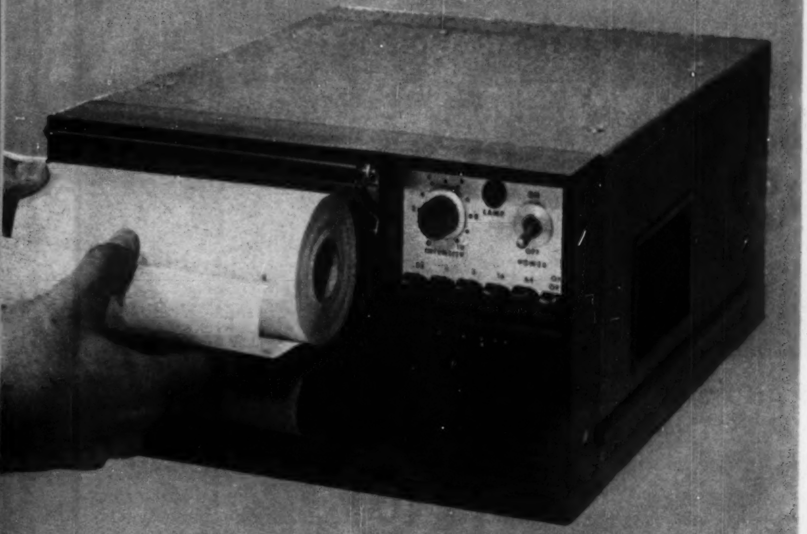
Send for NEW Bulletin No. 960-A, For Complete Information and Engineering Data

CRESCENT INSULATED WIRE & CABLE CO., INC.

TRENTON, NEW JERSEY

CIRCLE 87 ON READER-SERVICE CARD

load it...



NEW...THE EASIEST LOADING AND OPERATING RECORDING OSCILLOGRAPH AVAILABLE!

Just ten seconds! That's all it takes to drop in a roll of paper, push the button and you are recording 18 channels of data. No magazine or threading and operation is practically foolproof. Want to change recording speeds?... 1/4, 1, 4, 16, 64 inches per second? Just push a button.

The record is made by the print-out process, so there's nothing to do but watch it happen. No processing. It's right there in front of you. In fact, everything is in front: loading, controls, operating, viewing. And you can tuck it away in a rack without need for top or side clearance.

The 5-124 has 18 individual plug-in inputs to afford you the greatest flexibility in handling your data lines. It's a "big" oscillograph in a very small package. Even with its 7-inch-wide record and regulated power supply, it's portable. Carry it anywhere.

Economical to buy? About $500 more economical than the basic cost of a comparable unit. And the 5-124 is available with many optional features to meet your knottiest data recording problems.

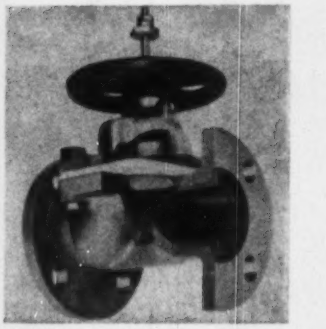
Five-speed transmission of the 5-124 is entirely pushbutton operated. Speeds can be changed while data is being recorded.
Write for Bulletin CEC 5124-X2.

Electro Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell · FINER PRODUCTS THROUGH IMAGINATION

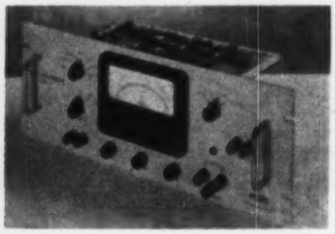
DIAPHRAGM VALVE



New 8-inch flanged-end Penton-lined Packless Diaphragm Valve is available with a cast-iron or aluminum body and with a wide variety of diaphragm materials. (Penton, a chlorinated ployether, which combines high chemical- and temperature-resistance with excellent dimensional stability, is a product of Hercules Powder Co.)—*Hills-McCanna Co., 4600 West Touhy Ave., Chicago 46, Ill.*

CIRCLE 226 ON READER-SERVICE CARD

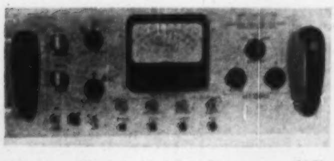
NULL VOLTMETER



New completely-transistorized, battery- or line-operated Null Voltmeter with full-scale ranges of 300, 30, 3 v, and 300 mv, features accuracy to 1½% of full scale, and measures the in-phase fundamental component of small a-c signals.—*Hydel, Inc., 223 Crescent St., Waltham, Mass.*

CIRCLE 227 ON READER-SERVICE CARD

SERVOAMPLIFIER

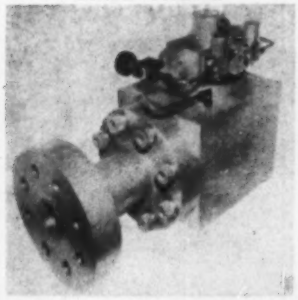


New Model 914. Servoamplifier drives all types of hydraulic and pneumatic servovalves, and many types of electrical components. Its high-power output is proportional to the difference of two input voltages; or, alternatively, the output may be panel controlled.—Bulletin gives details.—*Industrial Measurements Sales, Inc., 445 North Garey Ave., Pomona, Calif.*

CIRCLE 228 ON READER-SERVICE CARD

← **CIRCLE 88 ON READER-SERVICE CARD**

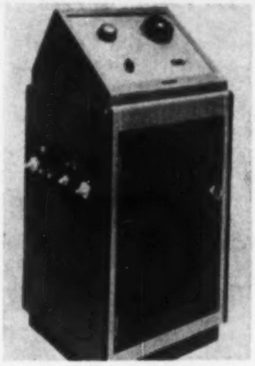
BALL VALVE



New Flo-Ball Valve releases up to 10,000 psi pressure in less than a third of a sec for carrier-based jet plane arresting gear. Made of stainless steel, the valve weighs more than 200 lb. A Hydromatics actuator makes possible the high operating speed necessary in this application.—*Hydromatics, Inc. 70 Okner Pkwy., Livingston, N. J.*

CIRCLE 229 ON READER-SERVICE CARD

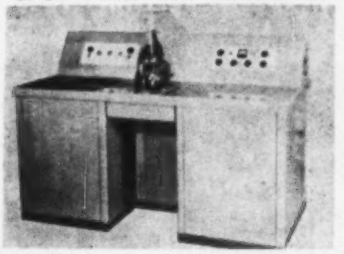
TRANSFORMER TESTER



New Uniload Current Transformer Testing Equipment, Type AL-2, with 25 ranges to 4000 amp contains a heavy-duty current-loading transformer, a high-accuracy current transformer standard, a variable-transformer current control, switches, over-load protection, etc.,—*Knopp Inc., 1307 66th St., Oakland 8, Calif.*

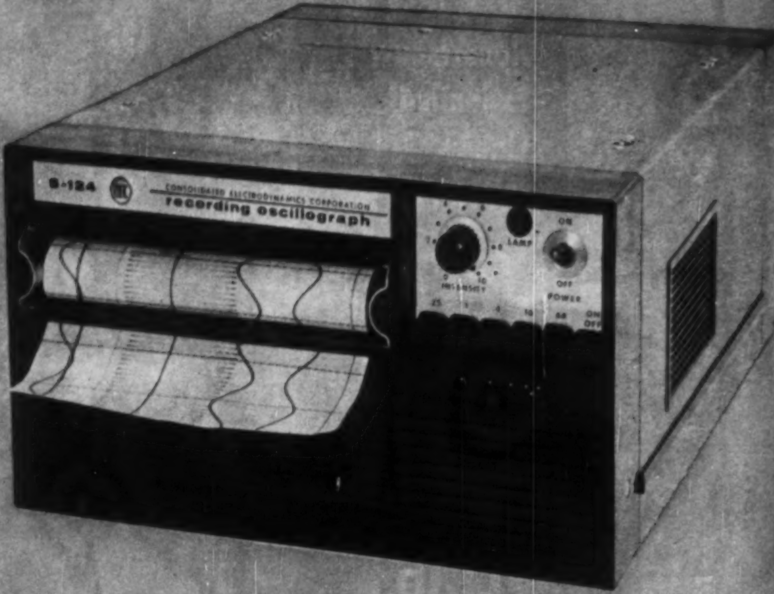
CIRCLE 230 ON READER-SERVICE CARD

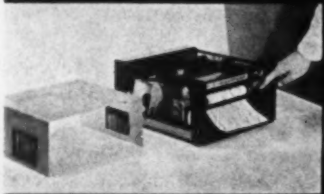
SPOT PARTICLE RESOLVER



New flying Spot Particle Resolver produces a picture of a microscopic subject on a cathode-ray tube providing magnification up to 8,000 dia with 700-line definition and a resolution of 0.0001 cm.—*Instrument Corp. of America, 1545 Kennewick Rd., Baltimore 18, Md.*

CIRCLE 231 ON READER-SERVICE CARD





CIRCLE 89 ON READER-SERVICE CARD →

read it!

NEW... HIGH WRITING SPEED OF 50,000 IPS...

through an exceptionally efficient optical system. Record resolution of the highest order is assured with trace widths of 0.010" or better.

For even faster record access-time than afforded by the standard print-out process, there is the optional DATAFLASH unit, which speeds the print-out process by a factor of 60.

Check this list of standard and optional features. Only the CEC 5-124 can offer them.

STANDARD FEATURES
6, 12 or 18 channels
15" long x 13" wide x 7⅜" high
115 volts, 50 or 60 cps, 500 watts
7" by 200' print-out record capacity
High intensity mercury-vapor light source
Intensity control
Unexposed footage indicator
Individual input connectors
Automatically regulated galvanometer lamp circuit

OPTIONAL FEATURES
Grid lines 1/10" or mm
Trace identification
Timing lines
Galvanometer block heaters

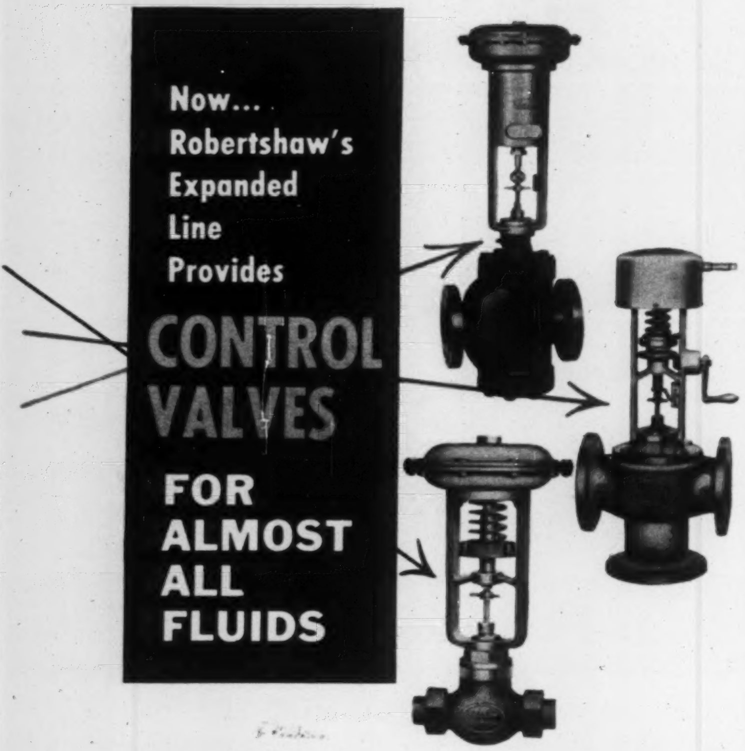
Modular construction of the 5-124 allows fast, easy access to all internal components for servicing. Operates with the cover off, too, for dynamic testing.
Write for Bulletin CEC 5124-X 2

Electro Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell · FINER PRODUCTS THROUGH IMAGINATION

Now...
Robertshaw's
Expanded
Line
Provides
CONTROL
VALVES
FOR
ALMOST
ALL
FLUIDS



We've stepped up our service in the valve field . . . and whatever fluid you're controlling, there's a good chance a Robertshaw precision-actuated valve will handle it.

New features . . . like our high-lift actuators, enclosed spring, and greater-area diaphragms . . . give you needed accuracy and serviceability, along with the ruggedness, simplicity and economy you've always received from Robertshaw.

- **Diaphragm and bellows actuators**
- **Two bellows areas—four diaphragm areas**
- **Reinforced Buna-N moulded diaphragm**
- **Single-seated, double-seated, three-way**
- **Quick opening, linear, equal percentage inner valves**
- **Choice of body and trim materials**
- **Union, screwed, flanged, welded ends**
- **Sizes ¼" to 10"**
- **Pneumatic or hydraulic operation**

Complete specifications in Folder TL–762. Write today.

Robertshaw

MR. CONTROLS

Robertshaw-Fulton Controls Company

FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE

CIRCLE 90 ON READER-SERVICE CARD

SOUND LEVER METER

New fully-transistorized, battery-operated Sound-Level Meter, Type 1400E, made by Dawe Instruments, Ltd., England, gives direct readings of sound-pressure levels over the entire audio range from 24 db to 140 db. It has a Rochelle salt crystal, diaphragm-type microphone which folds into a recess in the case. The mike feeds into a patented impedance matching circuit followed by a high-gain amplifier, an 11-position attenuator, calibrated in 10-db steps, and ASA-standard weighting networks.—*Korfund Co., Inc., 48-35A5 32nd Pl., Long Island City 1, N. Y.*

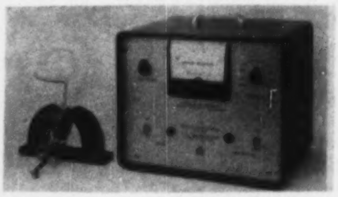
CIRCLE 232 ON READER-SERVICE CARD

HIGH-SPEED WEIGHER

New line of instruments includes high-speed weighing console using strain-gage load cells. Readability is 1 part in 10,000. Printer has keyboard for operator entry of data.—*Fairbanks, Morse & Co., Electronics Div., 505 Oakwood Ave., West Hartford 1, Conn.*

CIRCLE 233 ON READER-SERVICE CARD

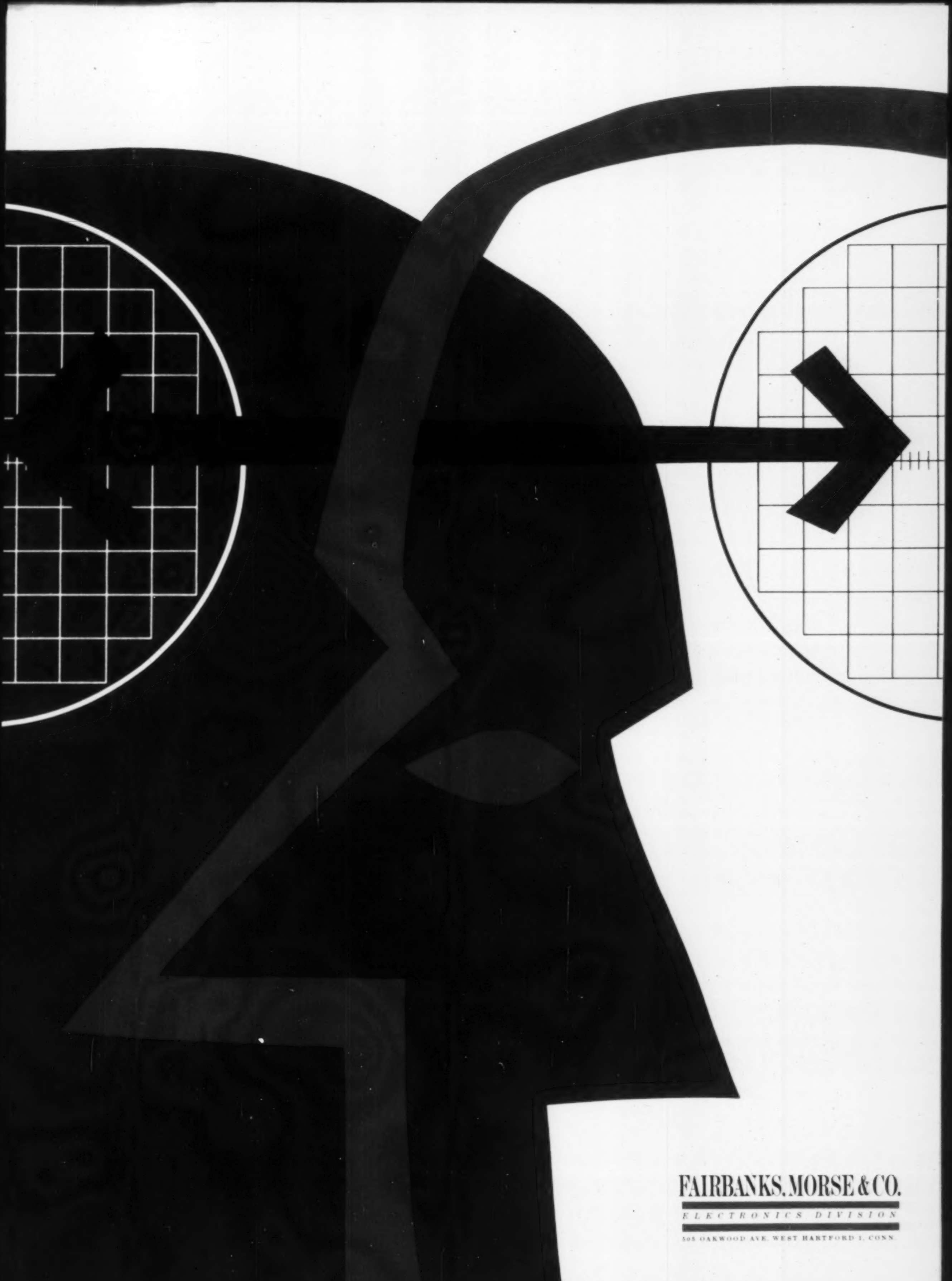
VACUUM GAGE



New Model 552 Redhead Magnetron Gage, an ultra-high-vacuum, cold-cathode Izonization Gage, is said to represent a major advance in the technology of extremely-low pressure measurement. It measures pressures between 1×10^{-4} and the 10^{-14} mm Hg range. Its sensitivity is claimed to be 50 times greater than the Bayard-Alpert type ionization gage.—*NRC Equipment Corp., 160 Charlemont St., Newton 61, Mass.*

CIRCLE 234 ON READER-SERVICE CARD

CIRCLE 91 ON READER-SERVICE CARD →



FAIRBANKS, MORSE & CO.

ELECTRONICS DIVISION

505 OAKWOOD AVE. WEST HARTFORD 1, CONN.

NEW ELECTRONIC DIVISION TO MEET YOUR EXPANDING NEEDS

We can now offer you the latest and finest in electronic equipment . . . and the service that goes with it.

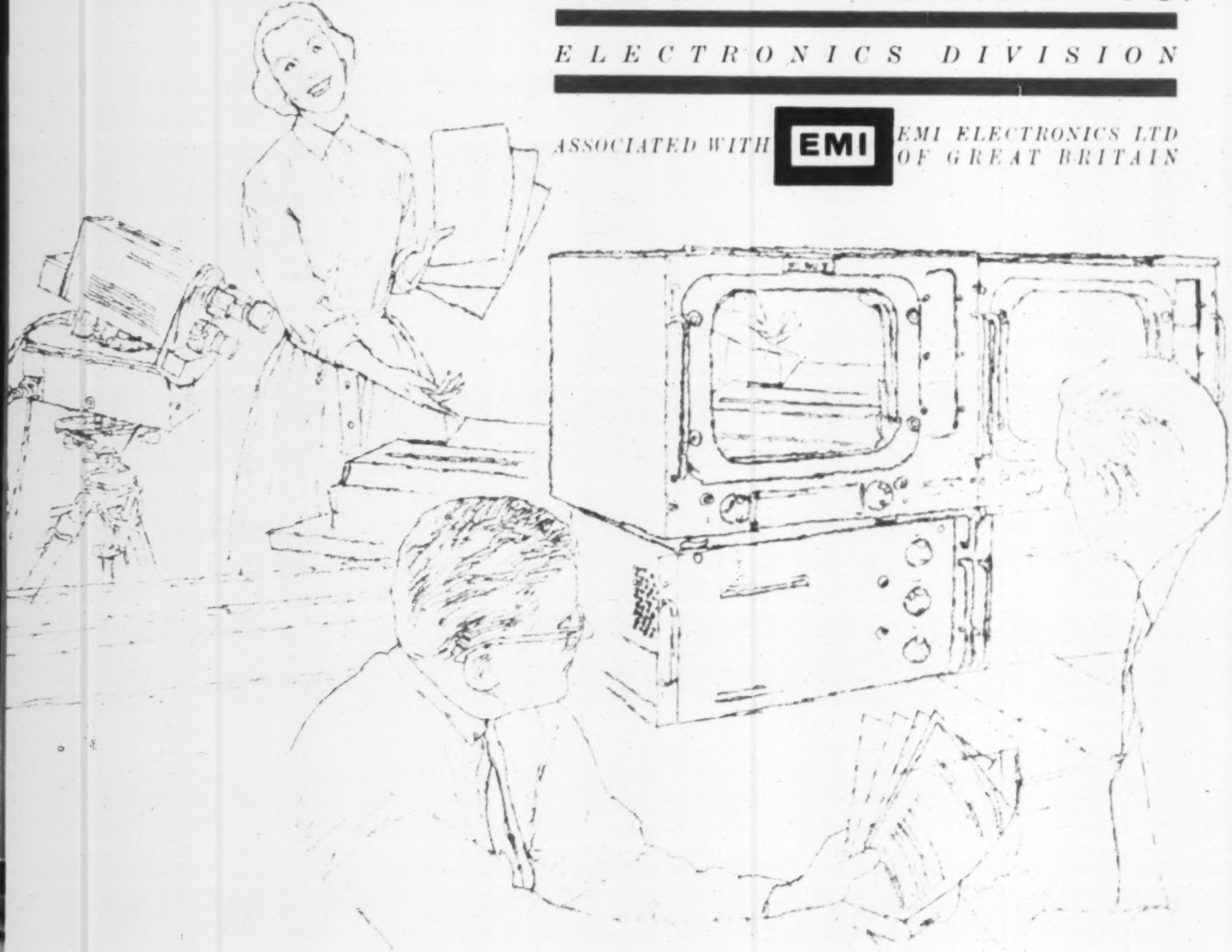
In addition to our own advanced line, we have become exclusive distributors for the most sophisticated equipment of one of the world-famed names in electronics—EMI Electronics, Limited of Great Britain. Both lines will be installed and serviced by a newly assembled corps of highly skilled technicians.

This combination of brainpower, skills and resources is your assurance that the machines and methods you need to compete today will be the ultimate in quality and efficiency.

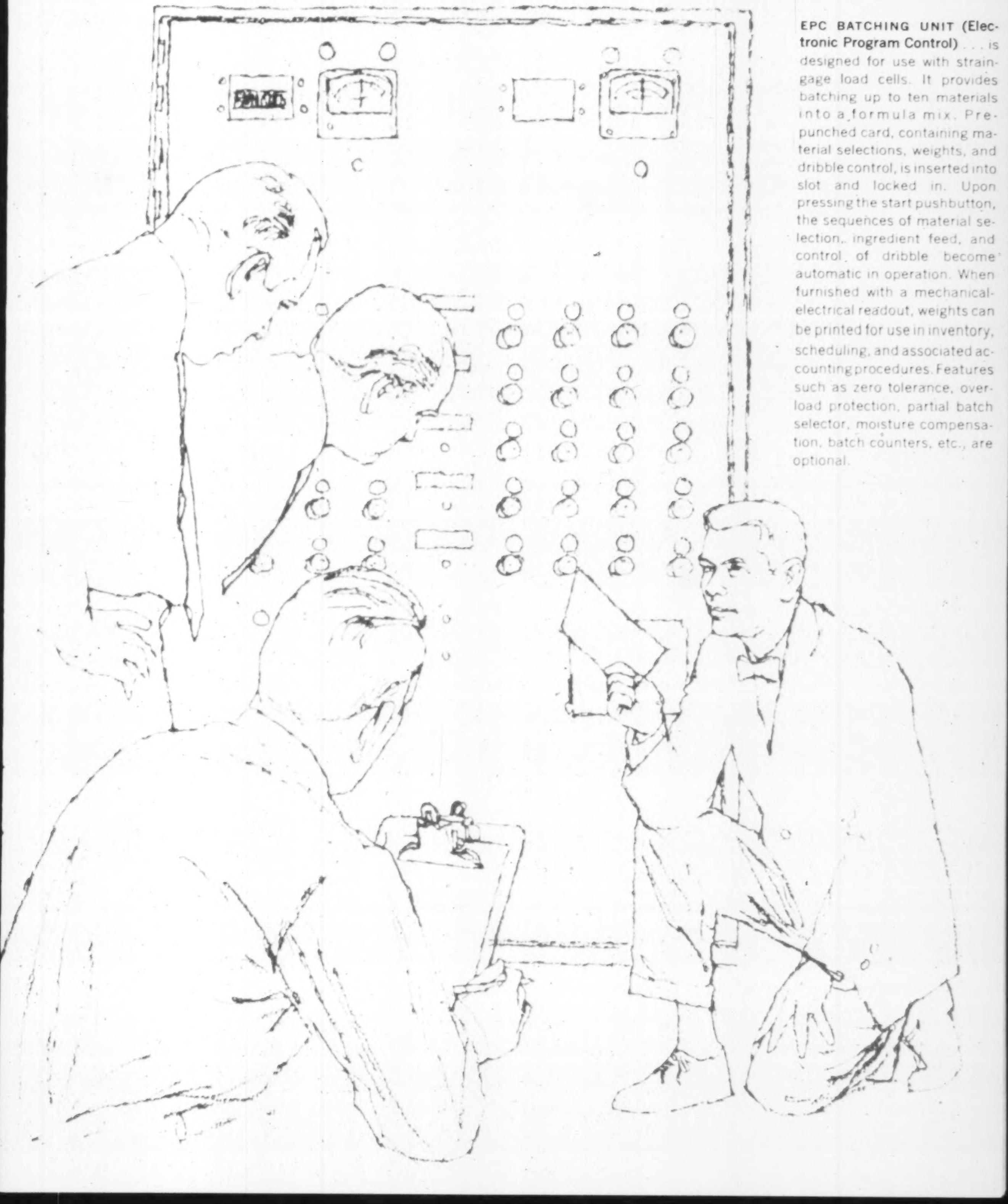
FAIRBANKS, MORSE & CO.

ELECTRONICS DIVISION

ASSOCIATED WITH **EMI** *EMI ELECTRONICS LTD OF GREAT BRITAIN*



CLOSED CIRCUIT TELEVISION . . . Management's latest, most useful partner. Simplifies production control, remote observation, property protection, dangerous viewing, traffic and process supervision, centralized record verification, surveillance . . . projects microscopic phenomena. Even ultra-violet or infra red, invisible to naked eye, can be seen. A helpful selling, sales promotion and trading aid, as well. Hundreds of other applications speed work, up production, cut costs. How can you use it?



EPC BATCHING UNIT (Electronic Program Control) . . . is designed for use with strain-gage load cells. It provides batching up to ten materials into a formula mix. Prepunched card, containing material selections, weights, and dribble control, is inserted into slot and locked in. Upon pressing the start pushbutton, the sequences of material selection, ingredient feed, and control of dribble become automatic in operation. When furnished with a mechanical-electrical readout, weights can be printed for use in inventory, scheduling, and associated accounting procedures. Features such as zero tolerance, overload protection, partial batch selector, moisture compensation, batch counters, etc., are optional.

Fairbanks, Morse & Co., Electronics Division
505 Oakwood Ave., West Hartford 1, Conn.

Please send detailed technical data on ☐ Closed Circuit Television ☐ EPC Batching Unit ☐ High Speed Weigher ☐ Oscilloscope ☐ Stroboscope ☐ Portable Contamination Monitor (Check booklets desired).

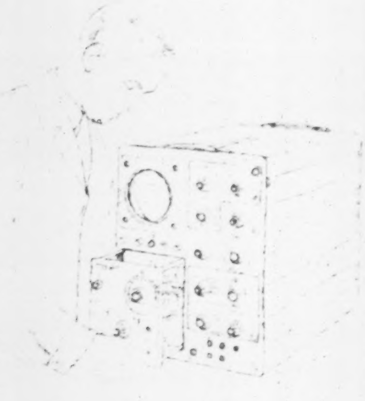
Name ....

Firm .... Title ....

Address ....

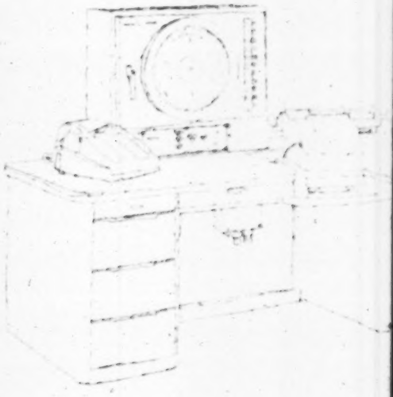
OSCILLOSCOPE TYPE WM 16

. . . Highly versatile instrument. Meets all general laboratory electronic work needs, also specialized work on radar, television, computers and millimicrosecond oscillography. Many outstanding features: fast rise time, excellent sensitivity 50 mV/cm, effortless time and voltage measurement. Unique plug-in units. Design eliminates special selection of replacement components and tubes.



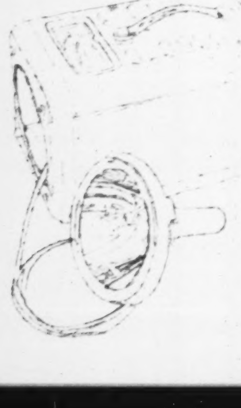
Q HIGH SPEED WEIGHER

. . . Instrument console also is designed for use with strain-gage load cells. Null-balance servo system features high-speed weighing with automatic ranging, balance detection, and print out. Readability is up to 1 part in 10,000. A standard printer is capable of up to a ten-digit entry printing cycle. The printer can be furnished with a keyboard deck for direct entry of data pertinent to the weight transaction.



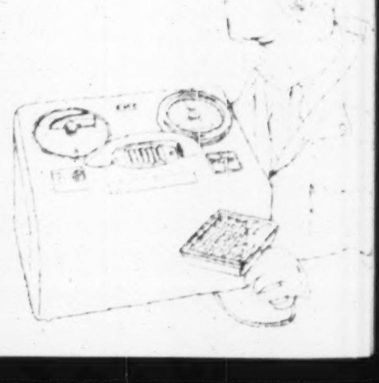
STROBOSCOPE & LAMP

General-purpose instrument designed to cover most needs in industry. Read-out pulse of 5 v peak-peak at output socket facilitates operation of ancillary equipment. Synchronized to lamp flash pulse will operate decade counter where greater accuracy in speed measurement is needed or trigger photographic equipment. Output impedance: approx. 5000 ohms. Frosted diffuser for silhouettes. Operates on 110-120v, 200-250 v, 50/60 cycles single phase.

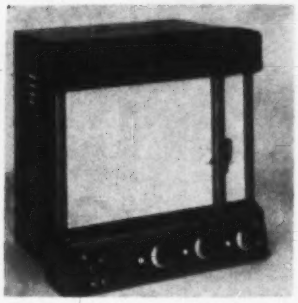


PORTABLE CONTAMINATION MONITOR. Type PCM 1

Revolutionary, new approach to concept of Alpha-Beta contamination monitoring. Two unique features: all transistor circuitry coupled with E.M.I. Dual Phosphor System. Outstanding advantages: simultaneous monitoring of Alpha-Beta contamination. Lightweight battery for true portability. Dependable, long-lived transistors, high accuracy over wide temperature range. Unit can also be used with other counters.



TWO-AXIS RECORDER



New two-pen, two-axis Graphic Recorder, Autograf Model 4B, plots $Y_1 = f_1 (x)$ and $Y_2 = f_2 (x)$ simultaneously, or, when the instrument's time base feature is used, it plots $Y_1 = f_1 (t)$ and $Y_2 = f_2 (t)$ simultaneously. A built-in sweep circuit provides the time base feature in the X axis.—*F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.*

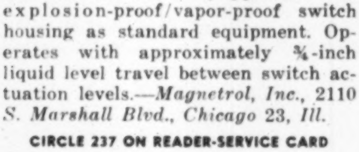
CIRCLE 235 ON READER-SERVICE CARD

SURFACE THERMOCOUPLE

New Miniature Thermocouple, Model E, with a sensing tip extension of up to 4", affords high-response surface temperature measurements through thick container walls. Features include response time of less than 10 μsec, continuous service temperature of 2000°F., and operating pressure range to 25,000 psig.—*Nanmac Corp., Dept. 109, Box 8, Indian Head, Md.*

CIRCLE 236 ON READER-SERVICE CARD

LIQUID LEVEL CONTROL



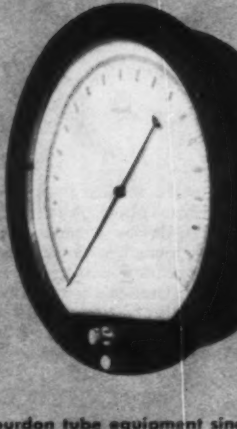
New Model 752, a single-stage, external-float-cage-style control can be either electrically or pneumatically switch-operated. Twelve float chambers are available. Equipped with an explosion-proof/vapor-proof switch housing as standard equipment. Operates with approximately ¾-inch liquid level travel between switch actuation levels.—*Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.*

CIRCLE 237 ON READER-SERVICE CARD

←CIRCLE 91 ON READER-SERVICE CARD

HEISE GAUGES

Test Standard ACCURACY



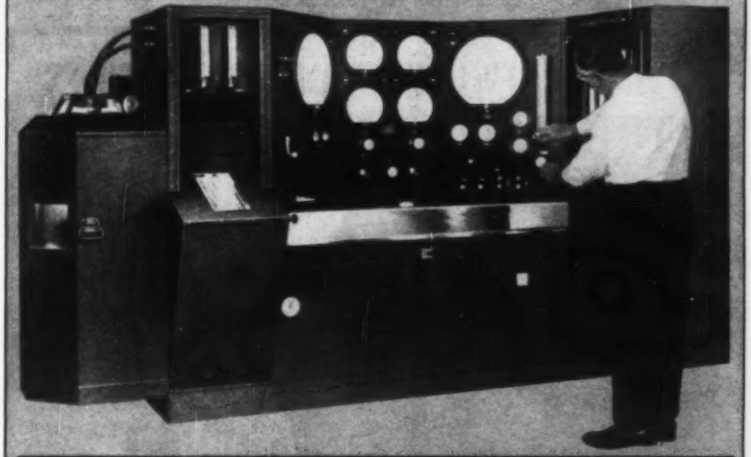
Only Heise gauge guarantees accuracy to 0.1 of 1% full scale reading at all points on a fully graduated 270° dial.

In laboratories throughout the world, the Heise gauge is being used as a test reference for recalibration of other instruments and testing of critical components.

All Heise gauges maintain the same standard of accuracy and are available in ranges from 0 to 15 p.s.i. to 0 to 100,000 p.s.i. Hysteresis, regardless of pressure range, is held within the same 0.1 of 1%.

The Heise laboratories, specialists in Bourdon tube equipment since 1930, have developed and perfected this instrument which stands alone in the field as a secondary standard approached only by the primary dead weight tester.

ACCURACY	HYSTERESIS	CAPACITY
0.1 of 1%	0.1 of 1%	0-100,000 p.s.i.



Dial Sizes	FULL SCALE READING (P.S.I.)						
	0-15 to 0-5,000 inclusive	Over 0-5,000 and including 0-20,000	Over 0-20,000 and including 0-30,000	0 to 40,000	0 to 50,000	0 to 75,000	0 to 100,000
8½"	$183.50	$205.50	$238.50				
12"	$209.50	$231.50	$264.50	$275.50	$286.50	$336.50	$386.50
16"	$255.50	$277.50	$310.50	$321.50	$332.50	$382.50	$432.50

DELIVERY — 2 WEEKS FOR MOST RANGES — PRICE F.O.B. NEWTOWN

***Request Catalog for* SPECIAL FEATURES**

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

CIRCLE 92 ON READER-SERVICE CARD

POST MEASURING SYSTEMS

Connected to any Post Decitron electronic counter, the new lineal footage device permits accurate length measurement for continuous production items.

Each time the wheel revolves, a photolight beam is broken and a count equal to one foot is registered by the counter. Varied "beam-hole", or wheel size will permit the counting of fractional parts of a lineal foot if desired. Different types of wheels provide traction surfaces for wire, rope, aluminum sheets, bar or flat steel, paper, cloth.

Used in conjunction with a Post Decitron "Preset" counter, (i.e. PW-2) a predetermined length of stock can be measured, and "marked" or cut-off as desired.

Ideal for labels and paper making where footage is most accurate measure of production.

Decitron

POST ELECTRONIC PRODUCTS

Division of Reid Brothers Company, Inc.

12 LOTHROP ST. / BEVERLY, MASS.

CIRCLE 93 ON READER-SERVICE CARD

CUSTOM BUILT OR FROM STOCK

NEW! CUSTOM GRADE CONSOLES AT LOW STOCK PRICES!

GENCO CABINETS & PANELS

- fit your space exactly
- fit your equipment exactly
- protect costly, fragile instruments

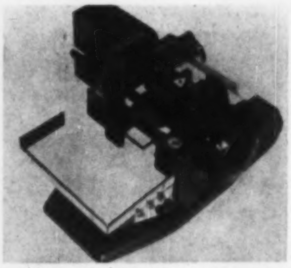
Now consoles, instrument panels, cabinets don't have to be either expensive custom installations or cheap stock items. **GENCO** brings you the benefits of each . . . custom-made at little more than stock prices.

NEW BRUNSWICK GENERAL SHEET METAL WORKS
425 Cleveland Avenue, Highland Park, New Jersey

........Rush my copy of new GENCO brochure.
........Have your representative call.
Name..
Company...
Street..
City..........................Zone........State............

CIRCLE 94 ON READER-SERVICE CARD

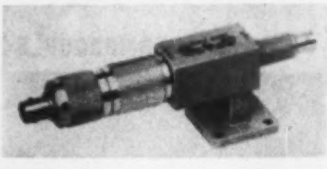
PUNCHED CARD READER



New Elliott high-speed Card Reader, handling standard (7⅜" x 3¼") cards with rectangular or round holes, 80 or 45 columns has a capacity of 600 cards with max. feed rate of 400 cards/min. Available from stock in five different models.—*Genesys, 10131 National Blvd., Los Angeles 34, Calif.*

CIRCLE 238 ON READER-SERVICE CARD

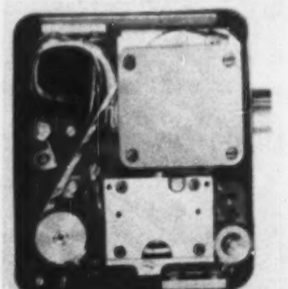
HARMONIC MIXERS



New Harmonic Mixers, Model P932A, fixed tuned for 12.4 to 18 kMc P-Band, and (2) Model 934A, for 1 to 12.4 kMc, operates with a H-P Model 540A transfer oscillator. The oscillator output is applied directly to the mixer, which generates harmonics and mixes them with an applied unknown waveguide frequency.—*Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.*

CIRCLE 239 ON READER-SERVICE CARD

PULSE PROGRAMMERS

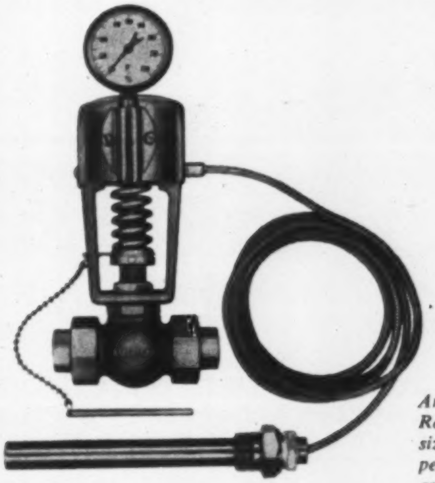


New Tape Programmer, Type RD15-101, is a 1200-pulse, 4-channel unit utilizing an endless loop of high strength polyester tape. Tape is stored on a removable cartridge for ease of handling. The unit can operate at a maximum rate of 30 pulses/sec with automatic resetting. Bulletin gives details.—*Lundy Mfg. Corp., Glen Head, L. I., N. Y.*

CIRCLE 240 ON READER-SERVICE CARD

immediate

AMERICAN TEMPERATURE REGULATORS begin corrective action with less than 1/10 degree change at the bulb



American Temperature Regulators are made in sizes ½" to 4". Temperature ranges as low as minus 15° F. to 50° F.—as high as 240° F. to 350° F.

response

You get fastest possible temperature response from these new regulators because the stem cannot bind and retard valve action.

The valve stem on American Temperature Regulators is sealed off by a friction-free bellows that makes practical a nonleaking packless valve. Also contributing to fast, stable action is the use of an extra-long preflexed adjusting spring. This spring permits a long range of temperature adjustment without disturbing valve sensitivity at normal levels.

There are other high-quality features in American Temperature Regulators: maximum use of stainless steel; standardized parts; the fewest possible components; and unitized assembly. In addition, compactness simplifies installation in "tight" locations.

Accurate temperature regulation and attention-free operation mean long-term economy. Your industrial supply distributor will gladly help you select the right American Temperature Regulators for your needs. Write for Bulletin 114A.

MAXWELL
MANNING
M&M
& MOORE INC
TRADE MARK

AMERICAN TEMPERATURE REGULATORS
A product of
MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

CIRCLE 95 ON READER-SERVICE CARD

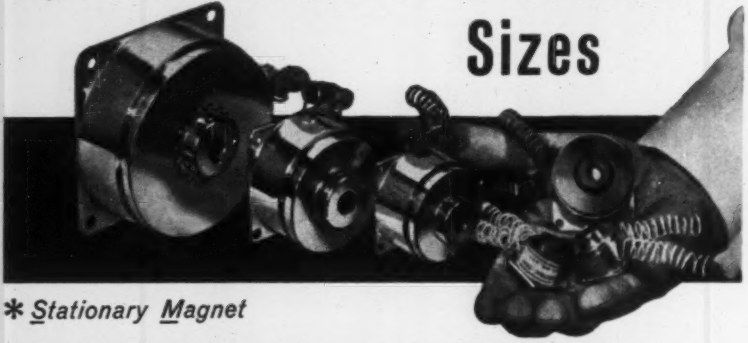
Stearns electro-magnetic

miniature

CLUTCHES

STYLE "SM"*

Now Available in **6 Standard Sizes**



* *Stationary Magnet*

Installation-Proved Reliability . . .
Users' expressed satisfaction on the long life and maintenance-free operation of the thousands of SM's in use on their applications confirms the advantages of the heavy-duty design and construction features of these units.

Wide Range of Size and Torque . . .
Six Sizes (shown above) — ⅞, 1⅛, 1 13/16, 2⅛, 2⅝, 4¼ in. square. Max. Torques Range from 25 oz in. to 240 lb in.

✓ ***Check—Compare these $aving Advantages:***

1. Heavy-Duty Construction for long, trouble-free life. Heavy-gauge frame resists distortion. Solid-type, low-carbon "Armco" steel armature for greater strength and longer wear. Solid, molded, fully finished metallic and asbestos friction element for longer, efficient life than a thin cemented facing. All wear elements can be quickly, easily replaced, if required, at low cost.
2. Fast, Easy Installation . . . stationary field with flange-type mounting. Most sizes available with option of extended, ball-bearing-mounted driven hubs for integral sheave or pulley mounting.
3. Self-Adjusting.
4. No slip-rings or brushes to install or maintain. Furnished standard with 12-in. to 14-in. wire leads. Terminal block or plug-in connections are optional.
5. Moisture-, Corrosion-Resistant . . . coil is embedded in an epoxy resin compound—not merely coated. All metal parts finished with a chromate-converted zinc plating.
6. Fast, Positive Actuation.
7. Assures accurate, dependable, power or motion control energized by any adequate switching device.

For Superior Performance—Reliability . . . Specify Stearns!
Contact your local Stearns Representative for complete data and information on how to obtain prototype units for your specific installation. Or write direct, stating specific application information. Request Bulletin No. 504-BV.

Stearns
ELECTRIC CORPORATION
120 North Broadway, Milwaukee 2, Wis.
Phone: BRoadway 2-1100

THE COMPLETE LINE OF CLUTCHES . . . BRAKES . . . CLUTCH-BRAKES

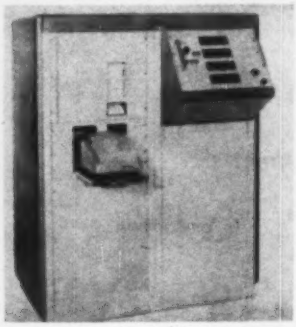
CIRCLE 96 ON READER-SERVICE CARD

SPLIT PACKING GLAND

New stainless Split Packing Gland, for bulb thermometers and similar applications requiring a pressure seal on the smaller diameter capillary tube after the larger diameter bulb passes through the gland body, has temperature range of −300°F to +1850°F and is good for pressure up to 7500 psig.—*Conax Corp.*, 2300 *Walden Ave., Buffalo* 25, *N. Y.*

CIRCLE 241 ON READER-SERVICE CARD

VALVE OPERATION ANALYZER



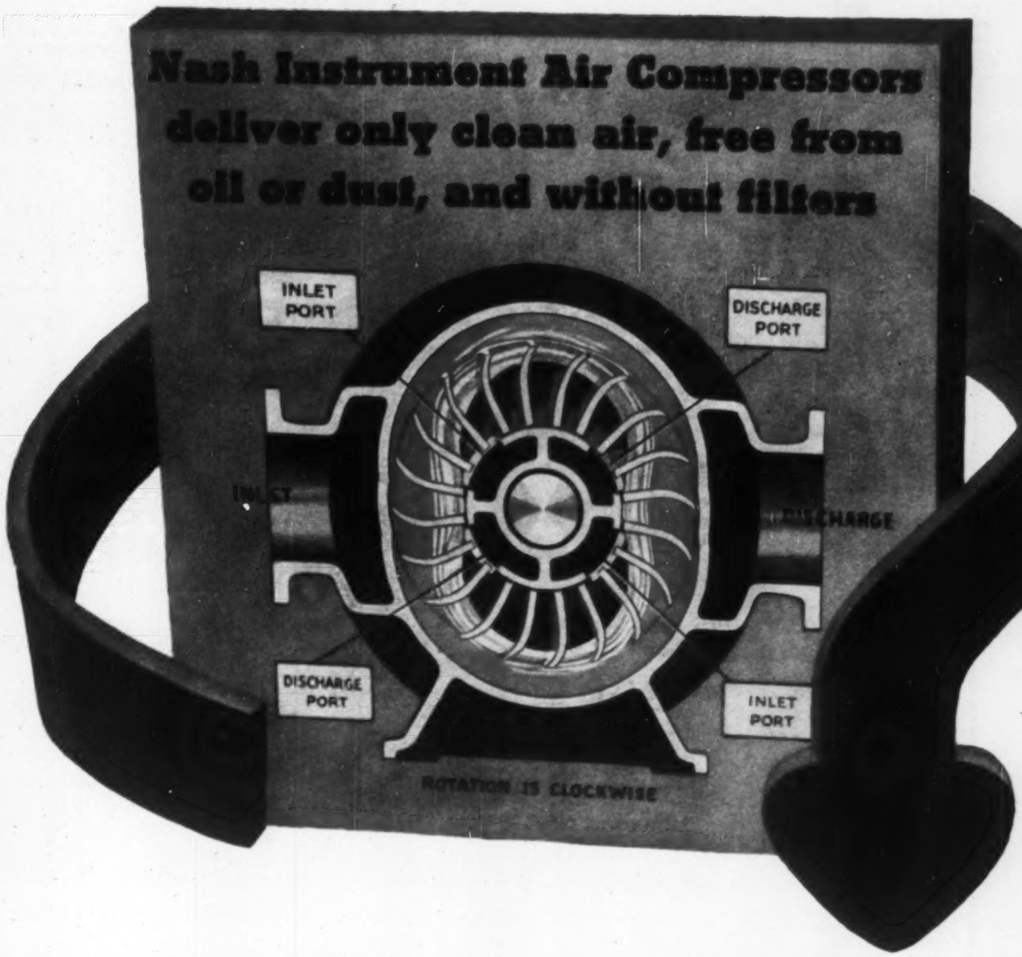
New Valve Operation Analyzer measures time intervals as short as 0.1 msec and presents the readings visually, in printed form and graphically. As many as 12 sequential events occuring within a three-second time span can be automatically timed. Provides also position-vs-time plots. —*Consolidated Avionics Corp.*, 800 *Shames Drive, Westbury, N. Y.*

CIRCLE 242 ON READER-SERVICE CARD

VACUUM GAGE

New GHD-100 line of completely-mechanical Diaphragm Gages for use in measuring total pressures of all gases from atmosphere to 0.2 mm Hg is for installation directly to a vacuum system and requires no electrical connections. Scale has a non-linear calibration which spreads the 0.2-20 mm region over 180°.—*Consolidated Vacuum Corp.*, 1775 *Mt. Read Blvd., Rochester* 3, *N. Y.*

CIRCLE 243 ON READER-SERVICE CARD


Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
INLET
DISCHARGE
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

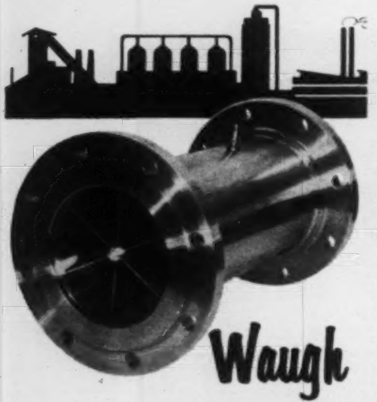
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



Waugh

TURBINE

FLOW METERS

for high accuracy

CONTROLLING

TOTALIZING

and

BLENDING

Waugh Turbine Flow Meters provide outstanding accuracy and reliability in fluid processes where blending in precise ratios, batch control, or flow rate control is required. Turbine flow meters have a **linear** output which simplifies totalizing, and maintains full accuracy in pulsating flow conditions. Accuracy is ½% of the flow rate over flow ranges as high as 20:1, and even better over narrow ranges.

Control devices designed for use with Waugh Turbine Flow Meters include solid state counters, totalizers, controllers, and complete digital blending systems to blend simultaneously as many as 20 different components.

Waugh Turbine Flow Meters occupy only a fraction of the space required for other flow meters of comparable accuracy. For example, a 4 inch Waugh Turbine Flow Meter, having an overall length of 10 inches, and no larger in diameter than the pipe itself, will measure flows from 60 to 1250 GPM, with an absolute accuracy of ½%, and a repeatability of better than 0.1%. A complete flow control loop includes only three elements: a flow meter, a controller, and a control valve.

FOR COMPLETE INFORMATION REQUEST WAUGH BULLETIN 114

Waugh

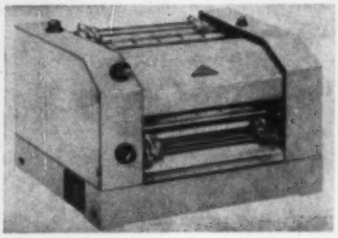
Engineering Representatives in Principal Cities

WAUGH ENGINEERING COMPANY

7842 Burnet Avenue, Van Nuys, Calif.

CIRCLE 97 ON READER-SERVICE CARD

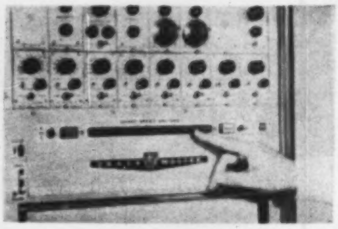
HIGH SPEED PRINTERS



New series of High-Speed Printers for readout from data processing systems is made in two basic series. One, the Series 4-1000-SD, offers normal printing rate of 1000 lines/min of alphanumeric characters and 2000 lines/min of numeric printing. The second, Series 4-500-DD, (substantially lower in price) offers 500 lines. —*ANelex Corp.,* 150 *Causeway St., Boston* 14, *Mass.*

CIRCLE 244 ON READER-SERVICE CARD

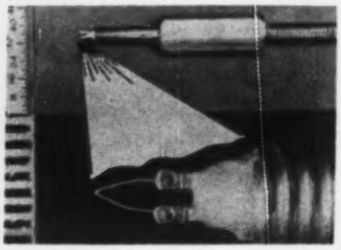
RECORDING SYSTEM



New electronic Trace-Master Recording System features (1) fidelity of reproduction (it operates over a frequency bandwidth 40%-100%); (2) an amplitude of 4 cm; (3) clarity, as it employs the direct-carbon-transfer method of writing; (4) permanence; (5) reproducibility; etc. Bulletin gives details.—*American Optical Co., Instrument Div., Buffalo* 15, *N. Y.*

CIRCLE 245 ON READER-SERVICE CARD

FINE WIRE T/C



New Fine-wire Thermocouple has a patent-pending mounting arrangement which provides a rugged instrument capable of detecting rapid gas temperature chances. Available in either 0.090" or 0.111" dia. (threaded with #4-48NF), with 0.001" or 0.003" dia wires. Miniature platinum-10% rhodium radiation shields are available. Common thermocouple materials can be supplied, including chromel-alumel, iron-constantan, and platinum-platinum-10% rhodium.—*Motech Co., Box* 6009, *Kansas City* 10, *Mo.*

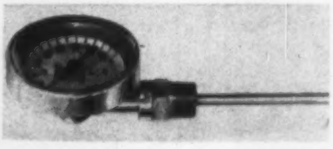
CIRCLE 246 ON READER-SERVICE CARD

EXCESS TEMPERATURE CUTOUT

New Pyrotac combines automatic protection against excess temperature with continuous temperature indication. Available in two models and eleven ranges from 0-400°F to 0-3000°F, as well as an environmental test chamber range of −100° to −300°F. Model N-30 will not shut off upon line-voltage failure; Model N-34 will shut off in such a condition.—*Alnor Instrument Co., Div. of Illinois Testing Labs., Inc.,* 420 *N. LaSalle St., Chicago* 10, *Ill.*

CIRCLE 247 ON READER-SERVICE CARD

INDUSTRIAL THERMOMETERS



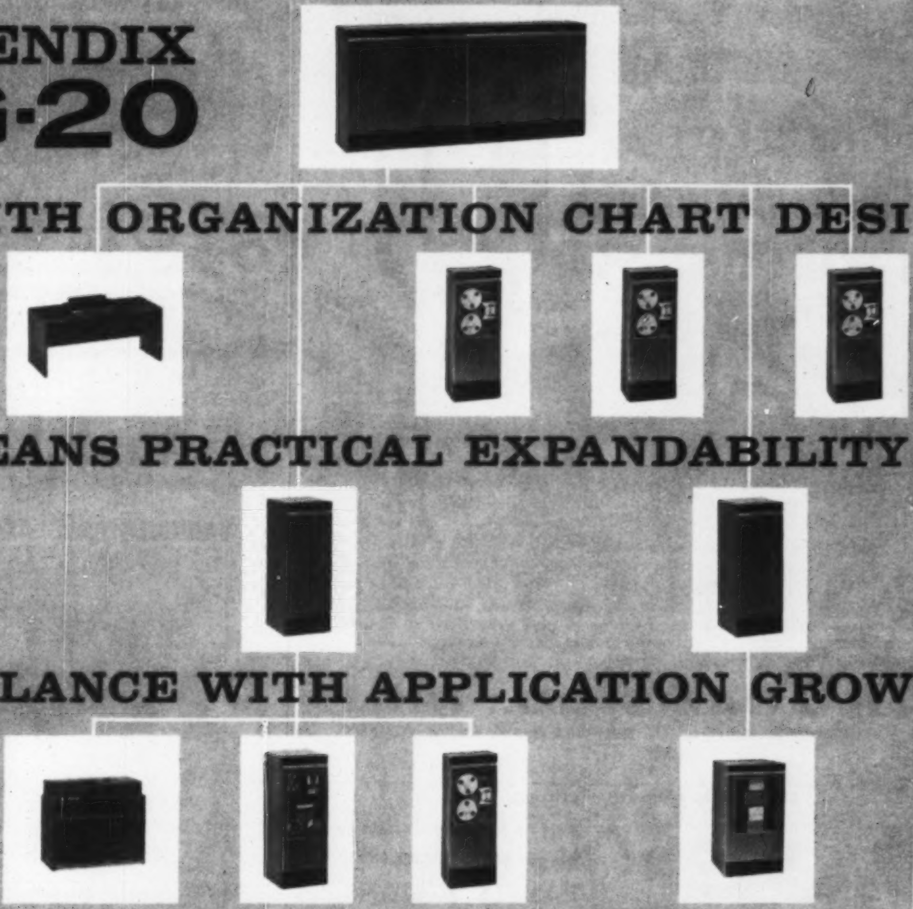
Bimet Thermometers in polished heavy-gage, all-stainless-steel cases, feature the exclusive anti-parallax face design and are hermetically sealed. Silicone dampening stabilizes pointers against vibration.—*Moeller Instrument Co., Inc., Richmond Hill, L. I., N. Y.*

CIRCLE 248 ON READER-SERVICE CARD

CIRCLE 98 ON READER-SERVICE CARD →

BENDIX G-20

WITH ORGANIZATION CHART DESIGN MEANS PRACTICAL EXPANDABILITY IN BALANCE WITH APPLICATION GROWTH

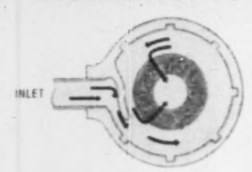


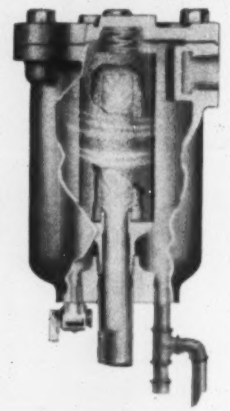
Just as the organization chart of any enterprise provides the framework for dynamic growth and adaptation, so "organization chart" design provides the framework for unparalleled expandability in the Bendix G-20 data processing system. This means that your G-20 can economically match, step by step, your expanding scientific or business computational workloads ... without sacrificing system balance. • Key to the organization chart efficiency of the Bendix G-20 is the ability of the Central Processor to "delegate" routine data handling tasks to control buffers, acting as "line supervisors." Thus freed, the Central Processor can make most efficient use of its high computation speed, its ability to schedule program priorities and direct accessory equipment assignments. • The ability to employ many control buffers gives new meaning to expandability in the Bendix G-20. Up to 70 input/output units can be directed by each of these "line supervisors." The Bendix G-20 has a complete line of accessory equipment including keyboard, paper tape, punched cards, high speed line printers, and 2 million word magnetic tape units. • Memory represents another dimension of G-20 expandability, ranging from 4,096 to 32,768 words. • Investigate the organization chart design of the Bendix G-20. See how it provides balanced, *practical* expandability ... at a cost that assures unequalled data processing performance per dollar invested. • *For detailed literature write:*

Bendix Computer Division
DEPT. J-27 LOS ANGELES 45, CALIF.

THE Bendix CORPORATION

ADAMS Poro-Stone Air Filters Keep Air Instruments Safe





Adams Poro-Stone Air Filters, removing entrained water, oil and dirt from your compressed air, assure less maintenance and longer life for your air instruments.

Passing through the millions of minute passages in the rigid Poro-Stone tube, air is literally scrubbed clean of damaging foreign matter.

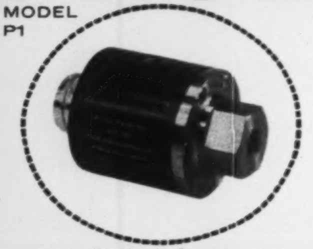
To relieve the load on the filter element, larger particles and droplets are knocked out by centrifugal separation immediately upon entering the filter housing. Non-absorbent, chemically inert Poro-Stone stays open for maximum efficiency. Occasional rinsing in solvent is all that's needed.

See how Adams Poro-Stone Air Filters can give longer life to your air instruments. Bulletin 117 is complete with design diagrams, specifying tables and application data. Write for your copy today!

R. P. ADAMS CO., INC.
265 EAST PARK DRIVE • BUFFALO 17, NEW YORK

CIRCLE 99 ON READER-SERVICE CARD

PACE
MODEL
P1



magnetic reluctance
PRESSURE
TRANSDUCER

Ranges: 0.1 to 1,000 psi — Gage, Differential and Absolute.

Pressure Media: Corrosive liquids or gases, both sides.

Withstands Extreme Pressure Overload.

Insensitive to Shock and Vibration — Not oil filled.

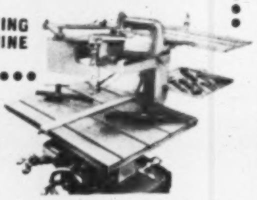
PACE's Model P1 is designed for low and medium pressure applications of laboratory accuracy.

PACE
engineering company
13035 Saticoy Street
North Hollywood, California
TRiangle 7-7139

CIRCLE 100 ON READER-SERVICE CARD

how to ENGRAVE PANELS & SIGNS to 30" wide by any length
Use the **LOW COST** *precision built* **PREIS-PANTO 2D-4**

ENGRAVING MACHINE



It does the work of larger machines, costing much more.

- Pantograph is graduated with reductions from 1:1 to 100:1 and will reduce to any size to infinity.
- Pantograph and spindle link joints equipped with precision ball bearings throughout.
- Precision ball bearing cutter spindle.
- Collet capacity from 1/10" to 1/4" and standard taper shank cutters.
- Six spindle speeds—5,000 to 14,000 rpm.
- All feed-screw dials graduated in .001".

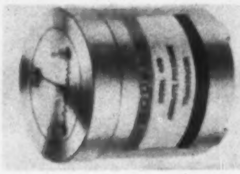
TRADE MARK
PANTO

Write for complete details and prices. For immediate attention write directly to manufacturer below. Ask for nearest representative.

H. P. PREIS ENGRAVING MACHINE CO.
661 U. S. Highway 22, Hillside, N. J.

CIRCLE 101 ON READER-SERVICE CARD

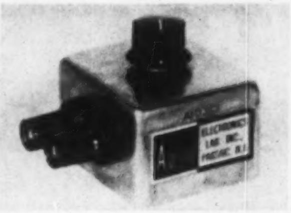
DIFF/ABS PRESS TRANSDUCER



New Models 409 Absolute Pressure Transducer (illustrated) and 509 Differential Pressure Transducer feature as sensing devices Ni-Span-C capsules whose displacement is transmitted through a unique multiplying linkage to the moving contact of a wirewound potentiometer. Exceptionally low friction characteristics and fine resolution are obtained with this mechanical design.—*Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.*

CIRCLE 249 ON READER-SERVICE CARD

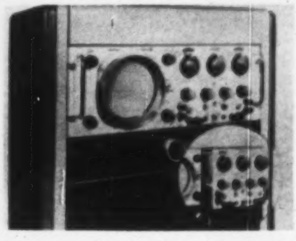
VARIABLE BANDPASS FILTER



New Variable Bandpass Filters, Type A103, made in audio frequency without vacuum tubes, transistors, or power supply in matched pairs are especially suitable for purifying distorted signals, for precision measurement of phase angle, or amplitude ratio. Electrical characteristics are identical in every way to a parallel resonant LC circuit.—*Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J.*

CIRCLE 250 ON READER-SERVICE CARD

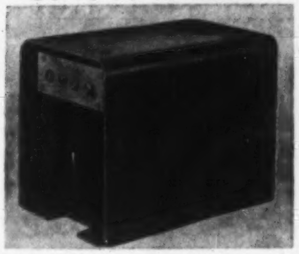
7" OSCILLOSCOPE



New 7-inch high rack mounted Osilloscope, Type 1100-R, is a basic cathode-ray indicator that is designed for incorporation into rack-mounted systems. There are 64 contacts available for the transfer of signals and voltages between the main frame and the plug-Ins. Details in bulletin.—*Analab Instrument Corp., 30 Canfield Rd., Cedar Grove, N. J.*

CIRCLE 251 ON READER-SERVICE CARD

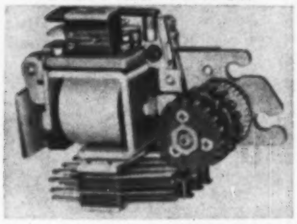
DC-TO-DC INVERTER



New DC-to-DC Inverter operates from a battery or similar 22-v-dc source. It has nine outputs widely varying in v-a ratings directly with input voltage variations. This variance can be corrected by the use of new Freed transistorized regulators. —*Freed Transformer Co., Inc.*, 1718 *Weirfield St., Brooklyn (Ridgewood)* 27, *N. Y.*

CIRCLE 252 ON READER-SERVICE CARD

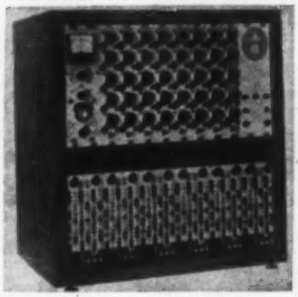
STEPPING SWITCH



New cam-operated Type 200 Stepping Switch makes an ideal memory device as but a single impulse is required to switch, and no power is required to hold it operated. Available in models with up to 8 cams providing 30-, 32-, or 36-tooth ratchets.—*C. P. Clare & Co.*, 3101 *Pratt Blvd., Chicago* 11, *Ill.*

CIRCLE 253 ON READER-SERVICE CARD

TABLE TOP COMPUTER



New table-top analog Computer, Model AD-1, basically contains from 4 to 32 amplifiers, depending upon applications. Modules may be used to expand the AD-1 to a full complement of 64 amplifiers. Four amplifiers are contained in each plug-in module. The approximate price of $3,000 for a complete 12-amplifier AD-1 is said to make the computer one of the most economical currently available.—*Applied Dynamics, Inc., Box* 2068, *Ann Arbor, Mich.*

CIRCLE 254 ON READER-SERVICE CARD

NOW AVAILABLE . . . A STANDARDIZED
CONTROL VALVE

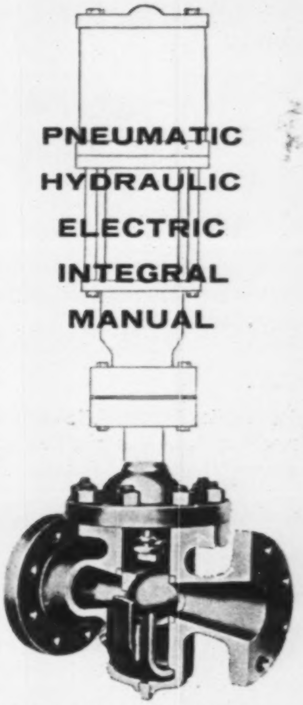
DESIGNED FOR THE
POWER INDUSTRY

CAPABLE OF . . .

- **HIGH PRESSURE DROP** — to 6000 psi, one stage
- **HIGH FLOW CAPACITY** — almost twice the C_v of the same nominal size globe valve
- **EXTREME TEMPERATURES** — −420°F to +1800°F
- **WIDE RANGEABILITY** — 100 to 1 "turn down" or better
- **TIGHT SHUT-OFF** — regardless of temperature and pressure conditions.

The straight-through Venturi design coupled with the unique patented control element of the ball and cage makes the General Kinetics' P-K Paul Control Valve ideally suited to both routine and critical applications. It is highly resistant to erosion and abrasion, and it offers long life and elimination or reduction of down-time with a resulting economy in overall cost.

The P-K Paul Valve is available in standard sizes from ¼" to 14" in accordance with ASA Standards. Larger sizes are available upon request.



P-K Paul Venturi-Ball Control Valve

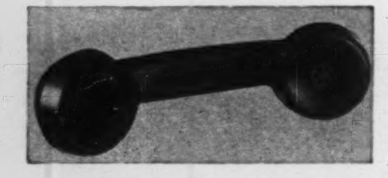
Write today for our new 16 page Technical Bulletin No. GV-101.

General Kinetics Corporation
197 South Van Brunt Street • Englewood, New Jersey
LO 7-3803 • TWX: ENGL NJ 1005

CIRCLE 102 ON READER-SERVICE CARD

STROMBERG-CARLSON TELEPHONE HANDSETS

MODELS FOR MANY INDUSTRIAL APPLICATIONS



No. 26: short, lightweight, sturdy. Comes with capsule-type receiver and transmitter.

No. 27: high-gain version of No. 26 handset.

No. 28: "push-to-talk" handset. Rocker bar switch; various spring combinations.

No. 29: high-gain version of No. 28 handset.

Typical applications: mobile radio • intercom systems • carrier and microwave • aircraft and railroad.

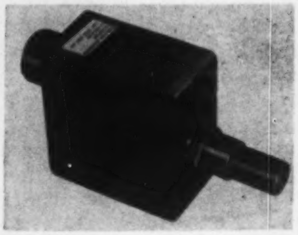
Modern handset cradle for mobile or panel use fits any Stromberg-Carlson handset.

Write to Telecommunication Industrial Sales, 113 Carlson Road, Rochester 3, New York. Or in Atlanta call TRinity 5-7467; Chicago: STate 2-4235; Kansas City: HArrison 1-6618; Rochester: HUbbard 2-2200; San Francisco: OXford 7-3630.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

CIRCLE 103 ON READER-SERVICE CARD

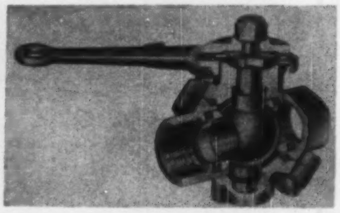
LIQUID LEVEL INDICATOR



New Liquid Level Indicator that does not depend upon capacitance or capacitors has an electronic control and a unique sensing element combined as a single unit, which can be mounted on industrial and aircraft engines, and installed where heat and vibration prevent the use of conventional indicators.—*Hamilton Standard, Electronics Dept., D-40, Broad Brook, Conn.*

CIRCLE 255 ON READER-SERVICE CARD

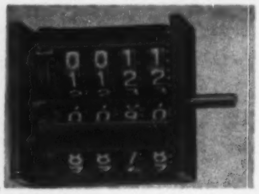
BALL VALVES



New Hi-Flo Ball Valve (formerly known in different markets as the "Bes-Val" or "Flo-Rul" valve) is now made in sizes from ⅜" to 2"; and 3", 4", 6", and 8" sizes will be available after the first of the year. Operating pressures extend to 1,000 psig, stocked in bronze and aluminum, stainless steel and ductile iron obtainable.—*Besler Corp., Valve Div., 4053 Harlan St., Emeryville, Oakland 8, Calif.*

CIRCLE 256 ON READER-SERVICE CARD

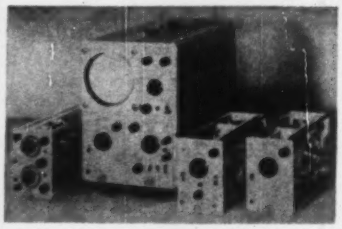
DUAL BANK COUNTER



New line of Model Y Dual Bank Counters for navigation and tracking equipment, machine tools, and all digital readout equipment where + and − readings are needed, features nylon wheels and pinions. Available in right-hand, left-hand drive, clockwise or anti-clockwise rotation, and with three, four or five digits.—*Durrant Mfg. Co., 1914-IS North Buffum St., Milwaukee 1, Wis.*

CIRCLE 257 ON READER-SERVICE CARD

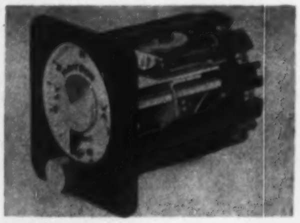
OSCILLOSCOPE



New Type 561 Oscilloscope is basically an indicator unit, the Type 561 containing a 5-inch crt with 3.5-kv accelerating potential, an 8 x 10 cm viewing area, an amplitude and sweep-time calibrator, and a husky power supply capable of handling additional contemplated plug-in modules.—*Tektronix, Inc., Box 500, Beaverton, Ore.*

CIRCLE 258 ON READER-SERVICE CARD

RESET TIMER



New Acrotime External Clutch Reset Timer that combines the functions of delay and interval timers, is designed on a modular concept. Line is available as Series BR for mounting in the rear of control panels. Series BP Timers are designed for panel mounting.—*Haydon Div. of General Time Corp., 245 East Elm St., Torrington, Conn.*

CIRCLE 259 ON READER-SERVICE CARD

PRECISION
JEWEL BEARING ASSEMBLIES . . .

**for AIRCRAFT • ELECTRICAL
MECHANICAL and
MARINE
INSTRUMENTS**

Sapphires set in brass, or other metal assemblies made in any quantity to close tolerance specifications are produced by Moser Jewel Company—*manufacturers of industrial jewels for over 50 years.*

Moser also provides highly polished pivots, staffs—silicon and spring loaded assemblies for high shock resistance.

SEND SPECIFICATIONS — DETAILED INFORMATION READILY GIVEN.

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J
P.O. Box 150 • Perth Amboy, N. J.

"Manufacturers of all types of Industrial Jewels"

CIRCLE 104 ON READER-SERVICE CARD

Carter

will this solve your motor problem?

Carter "Classic" f.h.p. GEARMOTOR
10 single and double reduction models,
10 to 750 r.p.m., 1 to 4 lb. in. torque.
Universal, shunt or series motors 12 v.
to 220 v. input. Size 6 x 3$\frac{5}{16}$ x 3⅜"

Governor available. Prompt delivery.
Liberal O. E. M. discounts.

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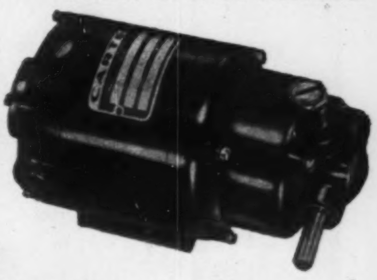

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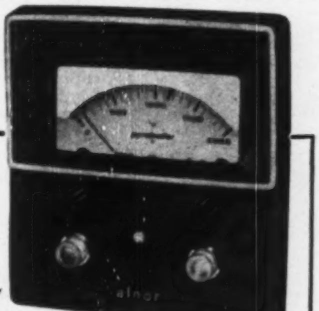
phone JUniper 8-7701
Sales Offices in Principal Cities

CIRCLE 106 ON READER-SERVICE CARD



NEW *Alnor* PYROTROLLER® Series N

An electronic temperature controlling instrument that automatically controls the heat source to maintain a constant temperature within a set range.

Designed for temperature control on heat treating furnaces, ovens, heat sealing equipment, plastic moulding machines, cooking vessels, or any application where a precise uniform temperature must be maintained.

The Pyrotroller has a modern designed aluminum case, is compact, occupying very little panel board space. The simple rugged circuitry has a minimum of components that operate well below their rated capacities.

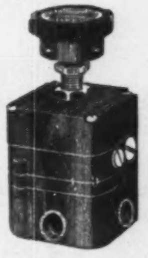
Write for bulletin

Alnor INSTRUMENTS

ALNOR INSTRUMENT CO.
Division of
Illinois Testing Laboratories, Inc.
Rm. 518, 420 N. LaSalle St., Chicago 10, Ill.

CIRCLE 105 ON READER-SERVICE CARD

WORLD'S MOST ACCURATE AIR-PRESSURE REGULATOR



- **Holds pressure to 1/5 of 1/10 of 1% of its range over substantial variations in supply pressure, flow, and ambient temperature. Resolution: 1 part in 10,000 of range.**
- **No exhaust-valve "pick-up" or initial drop-off on dead-end service. No drift with time or periodic shutdown.**
- **Designed for rugged service and minimum maintenance.**
- **50,000 user-tested for 6 years. Accepted as *primary standard of reference.***

You can prove it! This new air pressure regulator is the world's most accurate and reliable device for precise control of air or gas pressure. Yet it costs no more than other pilot-operated regulators.

Key to its unequalled accuracy and instant response is its patented high-gain servo design, which uses regulated rather than supply pressure, and its stainless steel pressure capsule

Available in 2-25, 3-60, or 3-120 psi ranges for ⅛", ¼", or ⅜" NPT pipe at 15 U.S. stocking points. Standard trade and quantity discounts. *Write now for data sheet and prices.*

Some territories are still open for qualified technical sales representatives.

Lexington Controls
INCORPORATED®
P. O. BOX 132-D, BURLINGTON, MASS.
PROTECTED BY U.S. AND FOREIGN PATENTS AND PATENTS PENDING.

CIRCLE 107 ON READER-SERVICE CARD

DO
YOU
USE
PRESSURE
REGULATORS?

SEND FOR NEW
FREE CATALOG ON
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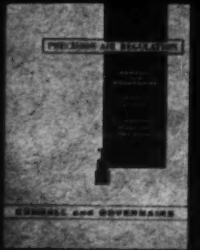
and
GOVERNAIRE®

Catalog gives performance and other data on 18 models of precision pneumatic pressure regulators (pipe sizes ¼" to ¾" NPT)



STRATOS®
A DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORPORATION
INDUSTRIAL PRODUCTS BRANCH
West Babylon, L. I., N. Y.

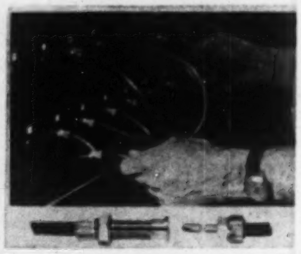
CIRCLE 108 ON READER-SERVICE CARD

REMOTE-READOUT MODULES

New Remote-Readout Modules for numerical data display provide six-digit in-line Nixie readout in a compact rack-mounted assembly. Model 342 is for service as a "slave" to the line of Apti-Meters; Model 343 is equipped for ten-line-per-digit input; Model 344 permits driving the Nixies from 1, 2, 2, 4 or 1, 2, 4, 2 binary-coded-decimal devices.—*Transistor Specialties, Inc., Terminal Dr., Plainview, L. I., N. Y.*

CIRCLE 260 ON READER-SERVICE CARD

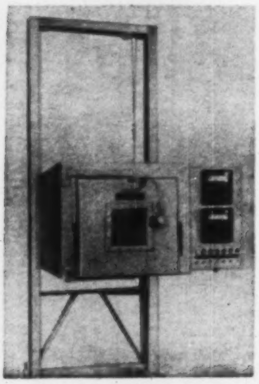
QUICK DISCONNECT



New Miniature Coupling for flush mounting with patented Brecoway locking mechanism features fast, easy one-hand connecting or disconnecting of air supply lines. Buna N Seals assure long lasting resilient sealing. Bulletin No. 125 gives details.—*Perfecting Service Co., 332 Atando Ave., Charlotte, N. C.*

CIRCLE 261 ON READER-SERVICE CARD

ENVIRONMENTAL TEST CHAMBER

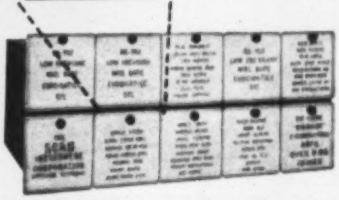


New wide-range Temperature Test Chamber for −300 to +1000° can be used with a vibration exciter in combined environmental testing. Accuracies are held to close tolerances by two control instruments, one for the high range (±3° to 1000°F), the other one for ±1° in the low temperature ranges.—*Missimers Incorporated, 3737 San Fernando Rd., Glendale 4, Calif.*

CIRCLE 262 ON READER-SERVICE CARD

NEW DE-LINE
annunciator has
70% MORE
ENGRAVING
AREA for more
precise
trouble legends

PA-102
LOW PRESSURE
MILL ROLL
LUBRICATING
OIL



Scam De-Line annunciators, your systems' sentry, now offers the new MAGNA-PLAC nameplate which provides 70% more engraving area.

The MAGNA-PLAC nameplate gives the engineer increased space to more accurately describe condition variations or to employ larger characters for greater visibility. It is interchangeable with standard Scam nameplates and optionally available *without extra charge.*

Other De-Line features include side or stack mounting for practical, *economical* system expansion; a single plug-in relay for both normally open *or* normally closed contacts; and sequence options *after* installation.

Yes, continuous product improvements such as MAGNA-PLAC, flexible application, ruggedness and reliability are what make De-Line the engineer's annunciator.

Complete Monitoring Systems for Industry

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Chicago 41, Ill.

Representatives in Principal Cities

WRITE FOR MORE INFORMATION on De-Line MAGNA-PLAC. Just sign and attach coupon to company letterhead.

NAME ______________________

CIRCLE 109 ON READER-SERVICE CARD

SCINTILLATION MONITOR

New Model AHM-11 Alpha Hand Monitor provides completely automatic detection and measurement of alpha contamination on the back and palm of each hand. Completely safe, error-proof monitoring is offered.—*Technical Associates*, 140 *West Providencia Ave., Burbank, Calif.*

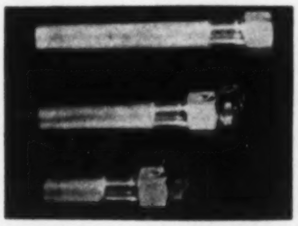
CIRCLE 263 ON READER-SERVICE CARD

SOIL RESISTANCE METER

New Model 293 Vibraground measures soil resistivity up to 86,650 ohms/cu cm when employed with a single-rod-resistivity set-up. Resistivity of soil test samples in soil boxes may be read directly up to 10,000 ohms/cu cm.—*Associated Research, Inc.*, 3777 *W. Belmont Ave., Chicago* 18, *Ill.*

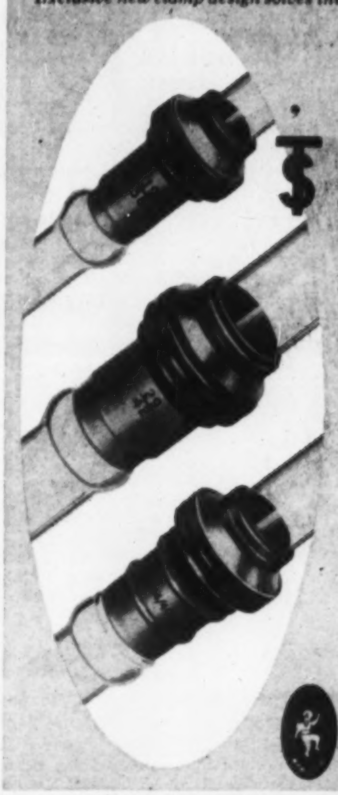
CIRCLE 264 ON READER-SERVICE CARD

SPECIAL THERMO-WELLS



New Econo-Wells in any immersion length up to 12" (upon special order) have 1" and ¾" NPT threaded connections, and flange connections.—*Trinity Equipment Corp., Cortland, N. Y.*

CIRCLE 265 ON READER-SERVICE CARD



Exclusive new clamp design solves the major problems of standard taper glass joints!

MANOSTAT
$ Joint Clamps

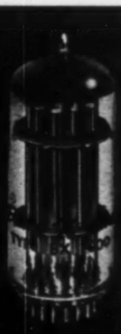
This practical standard taper glass joint clamp provides **positive adjustable closure;** fits into place without requiring disassembly of completed apparatus! Slim stainless steel clamps and plastic insert slip over joint from large end, lie closely over joint. Polypropylene inserts withstand up to 300° F., take up any stresses placed on glass as clamp is tightened!

Cat. No.	Size	Each	Per Doz.
JC-1100	10/30	2.20	23.76
JC-1150	12/30	2.50	27.00
JC-1200	14/35	2.60	28.08
JC-1250	19/38	2.70	29.16
JC-1300	24/40	3.35	36.24
JC-1350	29/42	4.15	44.88
JC-1400	34/45	5.50	59.40
JC-1450	40/50	8.50	91.80
JC-1500	45/50	10.00	108.00

See your local laboratory supply dealer.
Write for Bulletin JC.

MANOSTAT *Corporation*
26 N. Moore St., New York 13, N.Y.

CIRCLE 110 ON READER-SERVICE CARD



Beam-X SWITCH — COUNTING
Beam-X SWITCH — DISTRIBUTING
Beam-X SWITCH — MULTIPLEXING
Beam-X SWITCH — DECODING
Beam-X SWITCH — LOWEST COST $24.75
Beam-X SWITCH — SMALLEST SIZE - 1.1" x 3"
Beam-X SWITCH — LIGHTEST WEIGHT - 1.8 OZ.
Beam-X SWITCH — REPLACES 90 TRANSISTORS, RESISTORS AND DIODES

A NEW HIGH SPEED, 10 POSITION, ELECTRONIC SWITCHING DEVICE

Beam-X SWITCH

Burroughs Corporation

Write for BULLETIN BX 535.

CIRCLE 111 ON READER-SERVICE CARD

Lepel

HIGH FREQUENCY INDUCTION HEATING UNITS

HARDENING · ANNEALING
ZONE REFINING · CRYSTAL GROWING
SOLDERING · BRAZING

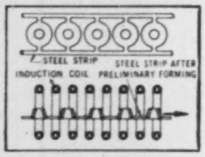
Lepel induction heating equipment represents the most advanced thought in the field of electronics . . . the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS

PLASTIC COATING OF TOOL HANDLES

A production line operation for coating handles of tools at Whitney Metal Tool Co., Rockford, Ill. uses induction heating with excellent results. The handles only are heated by induction to the desired temperature then dipped into a vinyl chloride base coating material for a short period depending upon the thickness of coating desired. The plastic coating formed on the handles is then cured by immersion in a carbo-wax bath.

FORMING OF METAL STRIP FACILITATED BY PROGRESSIVE ANNEALING



Metal forming operations which require intermediate anneals to restore ductility can be facilitated by induction annealing the strip progressively. Diagram illustrates this procedure for partially formed thin austenitic stainless steel strip. The induction annealing operation is scheduled in the production line between two press operations. Metal strip and wire of other materials are also induction annealed in this manner.

WRITE FOR NEW LEPEL CATALOG
Electronic Tube Generators from 1 Kw to 100 Kw
Spark Gap Converters from 2 Kw to 30 Kw

Lepel HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.

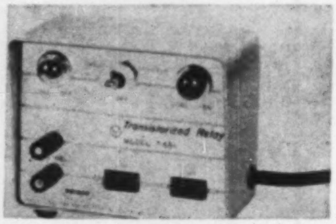
Chicago Office: 6246 W. North Ave.
CIRCLE 112 ON READER-SERVICE CARD

CERAMIC INSULATORS

New Ceramic Ferrules withstand temperatures to 2400°F and are abrasion and acid-resistant to all vapors and solutions except hydrofluoric acid. Available in a number of compositions, and made to specs with ID from ¼" to 2", in lengths up to 12".—*Saxonburg Ceramics, Inc., Saxonburg, Penna.*

CIRCLE 266 ON READER-SERVICE CARD

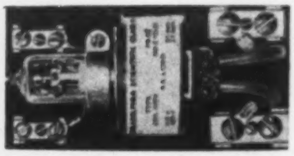
TRANSISTORIZED RELAY



New Transistorized Relay features higher input sensitivity permitting operation through 250,000 ohms across input terminals, high-temperature operation in ambients to 120°F, and switch lock on the front panel for positive control of either N-O or N-C loads. Pilot lights indicate position of contacts.—*Precision Thermometer & Instrument Co.,* 1434 *Brandywine St., Phila.* 30, *Pa.*

CIRCLE 267 ON READER-SERVICE CARD

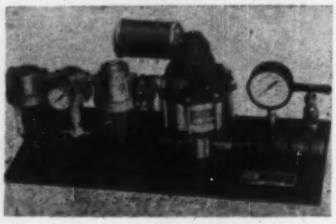
AC TEST LOAD



New Fluorescent Lamp Test Load for mercury plunger relays is available with coils for 115-v-or-230-v/50-60 cps operation. Contacts are SPST, NO or NC, nominally rated 35 amp and 50 amp on 115 v/50-60 cps or 25 amp and 35 amp on 230 v/50-60 cps. —*Philadelphia Scientific Glass, Co.* 470 *Paletown Rd., Quakertown, Penna.*

CIRCLE 268 ON READER-SERVICE CARD

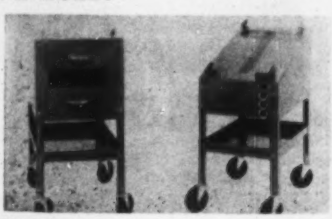
HYDRAULIC POWER UNITS



New air-operated Hydraulic Power Units for oil and water service in operating hydraulic equipment and in static and burst pressure testing. are made in two complete series, SC 40-500 with 10 models from 500 to 25,000 psi hydraulic pressure, and SC 40-600 with eight models from 1000 to 30,000 psi hydraulic pressure.—*SC Hydraulic Engineering Corp.,* 14032 *So. Avalon Blvd., Los Angeles* 61, *Calif.*

CIRCLE 269 ON READER-SERVICE CARD

PORTABLE SCOPE DOLLY

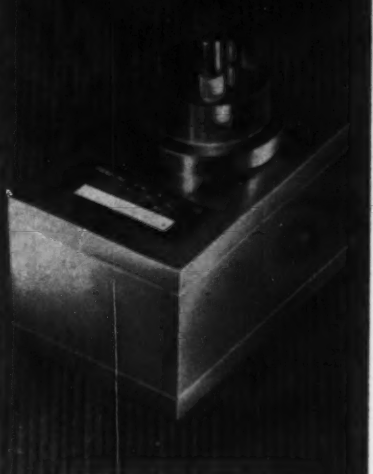


New Model 32957D Dolly is a low-cost unit for use in laboratory and shop which has a tilted supporting top. Louvres and small retaining angles provide maximum air circulation around the scope.—*PBR Mfg. Co.,* 863 *East Luzerne St., Phila.* 24, *Penna.*

CIRCLE 270 ON READER-SERVICE CARD

NEW

VIBRATING CAPACITOR



A vibrating-reed type capacitance modulator for use in measuring currents as low as 10^{-16} amperes.

Long term stability for process control. Drift ±0.2 millivolts per day, non-cumulative.

Write for Catalog 523.

STEVENS INCORPORATED ARNOLD

7 ELKINS STREET
SOUTH BOSTON 27, MASS.

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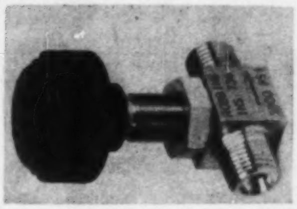
CIRCLE 113 ON READER-SERVICE CARD

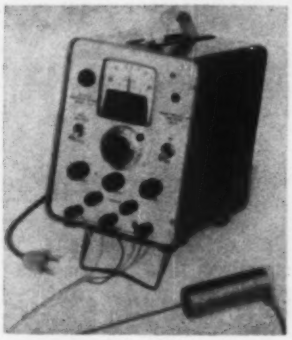
MINI METERING VALVE



New small globe-type INS736 Metering Valve with male ports, 14,000-psig burst pressure; suitable for manometer pressure gage or sampling use with gases such as air, nitrogen, oxygen, and helium, and with liquids such as fuels, hydraulic oils, and water; measures only 2.75" in height in the fully opened position.—*Robbins Aviation, Inc., 2350 East 38th St., Los Angeles 58, Calif.*

CIRCLE 271 ON READER-SERVICE CARD

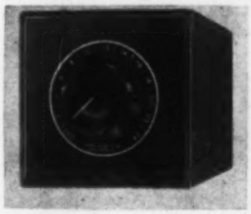
LIQUID LEVEL INDICATOR



New self-contained Kavlico Indicator System, Model 201A, for remote indication (up to 1000 ft) of Displacement or Liquid Level features accuracy of ±0.2% and provides d-c output for recording and control. Displacement down to 0.0005" can be measured.—*Vinson Mfg. Co., 8044 Woodley Ave., Van Nuys, Calif.*

CIRCLE 272 ON READER-SERVICE CARD

T/C SELECTOR SWITCHES



New Rotary (illustrated), Key, and Push-button Selector Switches for thermocouple and resistance thermometer applications provide rapid, accurate switching from one to 144 sensing elements. Rotary models stocked have capacity for 6, 12, or 24 points.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

CIRCLE 273 ON READER-SERVICE CARD

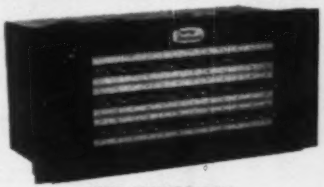
NEW Thermocouple **Selector Switches**

For fast, accurate indication of temperature from a number of thermocouples—to average readings from several measuring points—or to switch a thermocouple from one instrument to another—choose a new compact Thermo Electric Selector Switch.

These switches are compatible with any thermocouple or resistance thermometer, and any measuring instrument. Steel cases are dust and moisture proof, and are easily mounted on panel, rack, wall, or table.

ROTARY SWITCHES

Capacities—OFF to 6, 12 or 24 measuring points. Available with binding post terminals or bunched leads for soldered connections.



KEY SWITCHES

Accommodate 1 to 144 sensing elements—locking or non-locking construction. Choose from several different cabinets.

PUSH BUTTON SWITCHES

OFF to 72 points—interlocking construction so that one switch remains "on" until another is actuated.

Write today for catalog 24-2-12

Thermo Electric CO., INC.

SADDLE BROOK, NEW JERSEY
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

CIRCLE 114 ON READER-SERVICE CARD

$$\Delta E_0 = \frac{dE_0}{E_0} = \left[\frac{-1}{1+\frac{R_1E_2}{R_2E_1}}\right]\Delta R_1 + \left[\frac{-1}{1+\frac{R_2E_1}{R_1E_2}}\right]\Delta R_2$$

. . . This equation relates
operational amplifier accuracy to the error contribution in each of 2 coefficient resistors. It occurs on page 5 of our technical manual "Networks for Computers".

We manufacture resistors and networks that maintain **total** ΔE_0 accuracy of ±0.005% when required. This performance includes the effects of:

- Initial Tolerance
- Long-term Aging
- Wide Temperature Changes
- Self-heating
- Temperature Retrace Offset
- Voltage Retrace Offset
- Humidity Retrace Offset
- Mechanical Stresses

Ordinary "precision" resistors cannot even **approach** such performance . . . frequently are rated in terms of initial accuracy only. That is why the largest computer manufacturers purchase all critical resistors and networks from us. Prices are surprisingly moderate.

Free to computer design engineers

JULIE RESEARCH LABORATORIES, INC.
603 W. 130th St., New York 27, N. Y.
Telephone AUdubon 6-9200

NETWORKS
for
COMPUTERS
JRL

CIRCLE 115 ON READER-SERVICE CARD

Systems for Continuous Checking for Explosive Gases

J-W Model RV Alarms sample and analyze air at 2 to 8 locations and relay information to main analyzer panel. Recording instruments and explosion-proof construction available on order.

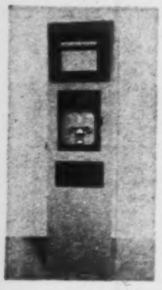
J-W Model SM Alarm continuously checks one location where accessibility is a problem; alarms at a pre-set level.

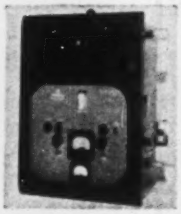
Do you have a problem with combustible gases that requires a special detection system design? Experienced J-W engineering is available to help you with meeting the situation. For complete data on services and standard and custom J-W equipment, please write:

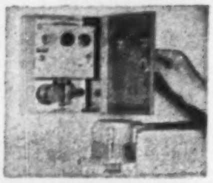
J-W Model E Alarm detects explosive gases in a single area; control box mounts remote from sensing unit. Model EE also available with units encased in explosion-proof housing.

JOHNSON-WILLIAMS, INC. Palo Alto 13, California
Leaders in Explosion Prevention Since 1927

Canadian customers please write: SAFETY SUPPLY CO. TORONTO, ONT. FLECK BROS. LTD. VANCOUVER, B. C.

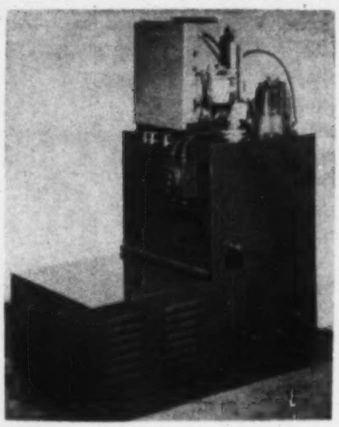






CIRCLE 116 ON READER-SERVICE CARD

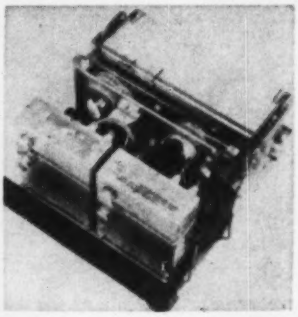
VISCOSITY CONTROLLER



New Stream Analyzer, an integrated Viscosity Controlling Package for monitoring in-line viscosities, permits the removal of fluid from a pressurized line, measurement of its viscosity, and its return to the line. It produces a steady flow of 1 gpm through a sampling chamber in which the viscosity measurement is made.—*Brookfield Engineering Labs., Inc., Stoughton, Mass.*

CIRCLE 274 ON READER-SERVICE CARD

STRIP-CHART RECORDER



New strip-chart Integrating Recorder, featuring high speed and superior operational flexibility, furnishes five different maximum count rates through an adjustable gear system up to a maximum of 40,000 area counts/min. The counting rate linearity is ±0.5% of full scale.—*Texas Instruments Inc., Geosciences and Instrumentation Div., 3609 Buffalo Speedway, Houston 6, Tex.*

CIRCLE 275 ON READER-SERVICE CARD

TELESCOPE

New 12-inch Telescope is claimed to perform with the same accuracy and precision as a professional observatory instrument. Magnifications of 80 to 800 times an object's diameter are produced by the telescope's 12-inch diameter Cassegrain optical system.—*Tinsley Labs., Inc., 2526 Grove St., Berkeley 4, Calif.*

CIRCLE 276 ON READER-SERVICE CARD

UP TO **75 POLES**

can be controlled by a single handle

with

ESCO Type JM ROTARY SWITCH.

Manufactured to BuShips drawing 815-1853019 and Specification MIL-S-21604.

- Sections .... up to 25
- Positions .... up to 12
- Action .... detent, 30° indexing
- Contacts break-before-make or make-before-break
- Rating 5 amp. 125 volts a-c at unity power factor
- Mounting .... back of panel

For detailed information ask for Bulletin 22.

ESCO of WEYMOUTH

ELECTRO SWITCH CORP.

Weymouth (Boston 88), Massachusetts

CIRCLE 117 ON READER-SERVICE CARD

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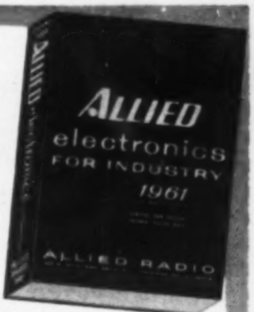

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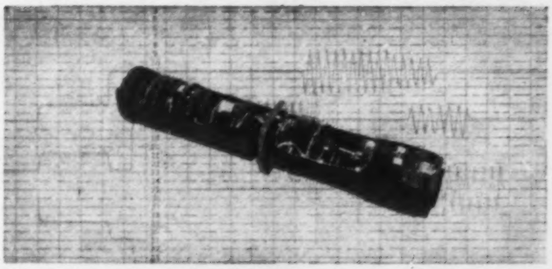
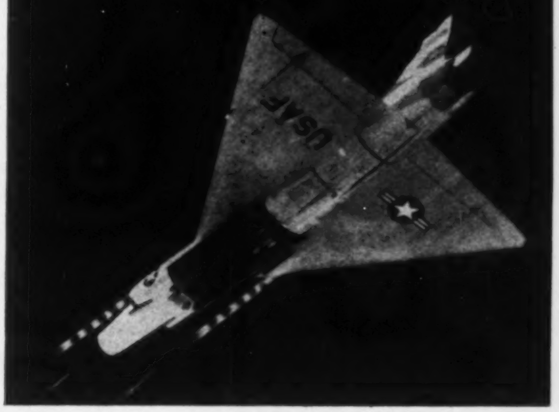
THANKS TO BRISTOL CHARTS



AND HATHAWAY RECORDER

...THIS MISSILE MAN IS A SHARPSHOOTER



A compact airborne recorder assembly made by Hathaway Instrument Division of Hamilton Watch Company, Denver, Colorado, is used in simulated firings to train pilots in use of the Falcon air-to-air missile.

This rugged instrument records firing data on photo oscillographic paper, preprinted with accurate amplitude and reference lines by The Bristol Company.

Bristol's chart service developed the new process which permits accurate (±0.005") printing through photo sensitive emulsions and produces preprinted photo charts for oscillograph use.

This is just one example of Bristol's ability to design a chart to meet your special instrument requirements. On specially treated, coated or laminated stock, if required. With special punchings or printing to any desired mathematical law.

Your instrument is no better than the chart it records on. So for more information on Bristol's long experience in chart engineering and accurate, economical production methods, write: The Bristol Company, 154 Bristol Road, Waterbury, Conn. 9.23

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New Line of corrosion-resistant needle valves

MARSH

Needle Valves

in 316 STAINLESS STEEL

Throttle flow and throttle corrosion with this new valve series that gives you the superlative construction of Marsh Needle Valves with the corrosion-resistance of 316 stainless steel.

Here is a valve that gives you precision throttling and tight closure on pressures from a few pounds to 6000 psi. Wide temperature range, too—from minus 100°F. to plus 500°F. —as a result of the Marsh "Marpak" packing system utilizing precision moulded Teflon.

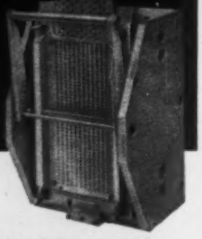
New 316 stainless series (series 1936) is identified by blue handle. Sizes from ⅛" to 1"; globe, angle, and panel mounted patterns.

Marsh Needle Valves are also available in 416 stainless steel (identified by green handles) and in alloy steel (identified by yellow handles).

Ask for bulletin NV-3

MARSH INSTRUMENT COMPANY, Dept. 42, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd., 9487 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

CIRCLE 120 ON READER-SERVICE CARD



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Reads Entire Punched Card Statically

FOR

Simple Switching Using Standard Punched Cards

Taurus Punched Card Sensors statically read entire standard I.B.M. or Remington Rand punched cards.
Each hole position has a corresponding closed switch, and each unpunched hole position has a corresponding open switch when the Sensor is actuated. Used for Automatic Test Equipment and other automation devices.
Taurus also produces a complete line of Standoff and Feedthru Terminals insulated with Teflon*. *REG. T.M. OF E. I. DUPONT

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A complete line of gauges in stock available for early delivery. Gauges from 10-inches water pressure to 30,000 P.S.I. to meet your specifications on any equipment.

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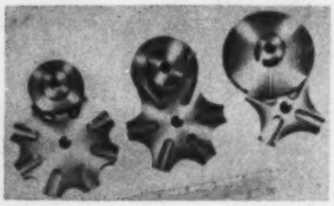
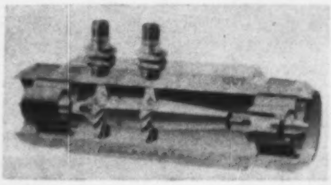
MINI GENEVA DRIVES



New line of Micro-Geneva Miniature Geneva Drives is for shaft sizes from 0.250" to 0.500" dia by $\frac{1}{16}$" increments. Available from stock in 4-, 6-, and 8-point drives with driver to wheel center distances from 0.750" to 2.000" by ⅛" increments.—*Miniature Mechanisms, Inc., Box 10386, Tampa, Fla.*

CIRCLE 277 ON READER-SERVICE CARD

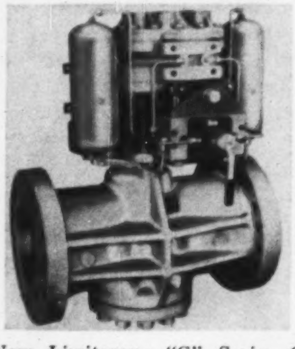
MASS FLOWMETER



New self-contained Series 3000 Mass Pottermeter measures liquids or gases in absolute mass units and provides repeatable accuracies to ±¼% of reading with linear response over a ten-to-one range. Two sets of blades tend to rotate at different speeds, but cannot because of a spring coupling. The magnitude of an angular displacement is proportional to the flow momentum.—*Potter Aeronautical Corp., Union, N. J.*

CIRCLE 278 ON READER-SERVICE CARD

VALVE OPERATOR



New Limitorque "G" Series Gas Operator, mainly for rotary plug valves, utilizes gas pressure from the pipeline and is easily mounted in any position. It requires no external gearing, and is readily adaptable for field mounting. 8-page bulletin gives details.—*Philadelphia Gear Corp., King of Prussia, Penna.*

CIRCLE 279 ON READER-SERVICE CARD

NEW PACKLESS

Stainless Steel Solenoid Valves

½" to 2"—Piston Pilot Operated
⅛" ¼"—Direct Lift

"Velvetrol" cushioned closing eliminates damaging shock . . . Packless . . . Meet wide range of service and pressure requirements . . . Body and all internal parts stainless steel . . . Guaranteed coils hermetically sealed in thermoplastic casings, and glass-wound silicone insulated for high temperatures.

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Bulletin K . . . Stainless Steel Solenoid Valves
Bulletin 500-B . . . Bronze Solenoid Valves

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SOLENOID VALVES

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40-POUND BENCH MODEL 106

Here is a speedy, economical 2 or 3-dimensional engraver used by thousands of dollar-conscious companies. It features 5 positive, accurate pantographic ratios; ball bearing spindle with 3 speeds up to 14,000 rpm. Is supplied with one copy carrier that accepts all standard master type sizes. Will actually work up to 10" by any width. Height of pantograph and position of cutter are continuously adjustable.

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Pantograph for milling, drilling and engraving.

Vertical adjustment of copy table automatic with Pantograph. Features: unobstructed on 3 sides to take large work; micrometer adjustment for depth of cut; ball bearing construction throughout; spindle speeds up to 26,000 rpm for engraving or machining; vertical range over 10"; ratios 2 to 1 to infinity — master copy area 26" x 10"

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MODEL D2-201
PNEUMATIC
ATTACHMENT

for use with Model D2 Pantograph Engraver to rapidly drill holes in printed circuits by tracing templates. Drills as many as 100 holes per minute. Equipped with foot switch; spindle air cylinder; regulating valve and pressure gauge; filter and oiler. It's ready to use as soon as it's attached to an air compressor

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greater reliability for soldering pin-type plugs, aircraft connectors, wire-to-wire, terminals, instruments, printed circuits, electronic systems and parts.

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*Proved by on-the-job comparisons . . . ask for Bulletin C217

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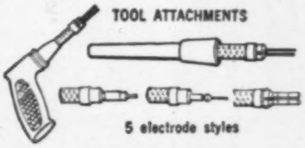
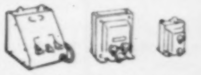


5 electrode styles

3 POWER UNIT SIZES



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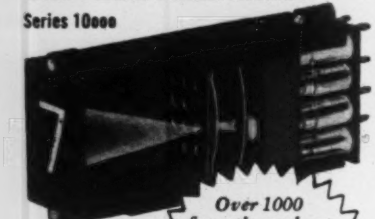

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Inductance, Resistance and Capacitance Decades in extra-compact and rugged design for accurate and dependable performance. Quality components used throughout to provide the same precise quality standards, electrically and mechanically, as finest lab-type equipment.

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New Bedford Massachusetts

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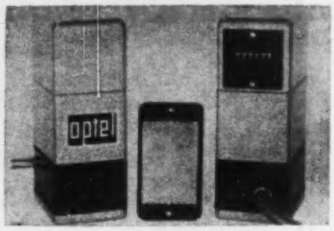
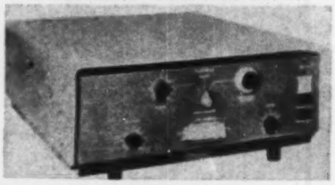
PHOTOELECTRIC COUNTER



New Optel Model PLS20 is a packaged Photoelectric Counting System comprising optics, light source, power supply, photoresistor, transistor amplifier, and 6-digit push button reset counter. The counter is driven directly from the transistor amplifier at rates up to 600/min.—*Presin Co., 2014 Broadway, Santa Monica, Calif.*

CIRCLE 280 ON READER-SERVICE CARD

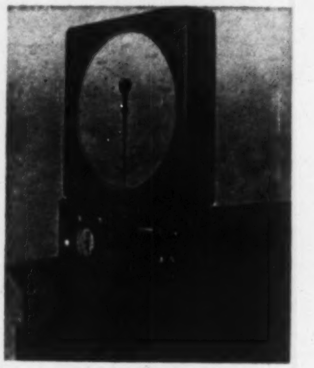
FURNACE CONTROLLER



New Model SPY 5064 Thermac Furnace Controller operates by continuously proportioning the output of two air-cooled thyratrons from 3% to 95% of their rated power (40 amp at voltages up to 600 v). It uses for its control reference either a manually adjustable, temperature-calibrated, set-point potentiometer, or a voltage from a remote programmer or computer.—*Research, Inc., Box 6164, Minneapolis 24, Minn.*

CIRCLE 231 ON READER-SERVICE CARD

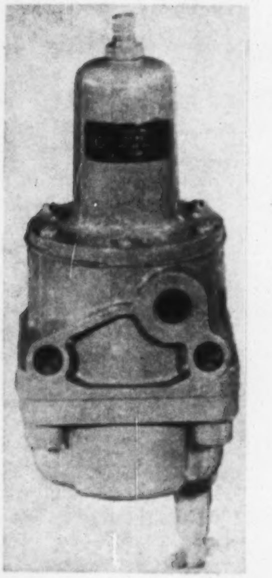
ELECTRONIC SCALE



New line of Ametron Weighing Systems is custom designed with any combination of built-in accessories needed for a particular application. Weights can be printed on tape or ticket, visual, or a combination of both. Bulletin gives details.—*Streeter-Amet Co., Grayslake, Ill.*

CIRCLE 282 ON READER-SERVICE CARD

FILTER REGULATOR



New "800" Filter Regulator, has a maximum inlet pressure of 250 psig and outlet pressure ranges of 0-5, 5-35, and 35-100 psig.—*Rockwell Mfg. Co., Meter and Valve Div., 400 N. Lexington Ave., Pittsburgh 8, Pa.*

CIRCLE 283 ON READER-SERVICE CARD

FREED
VARIABLE TEST VOLTAGE
MEGOHMMETER NO. 1620

The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

- Resistance — 0.1 megohms to 4,000,000 megohms.
- Voltage — variable, 50 - 1000 volts.
- Accurate — plus or minus 5% on all ranges.
- Simple — for use by unskilled operators.
- Safe — high voltage relay controlled.
- Self contained — AC operated.

OTHER MEGOHMMETERS AVAILABLE

Type 1620C MEGOHMMETER — a type 1620 with additional circuitry for testing capacitors.
Type 1020B MEGOHMMETER — a 500 volt fixed test potential. Range 1 megohm to 2 million megohms.
Type 2030 PORTABLE MEGOHMMETER — battery operated 500 volt test potential. Range 1 megohm to 10 million megohms.

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1707 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N.Y.

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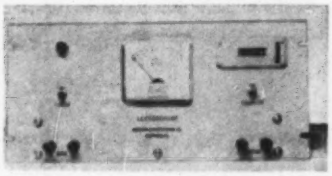
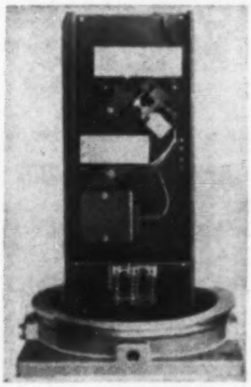
ELECTRONIC INTEGRATOR



New Electronic Integrator counts up to 10,000/min in the form of pulses, and integrates by monitoring input without using a recorder.—*Royson Engineering Co., Hatboro, Penna.*

CIRCLE 284 ON READER-SERVICE CARD

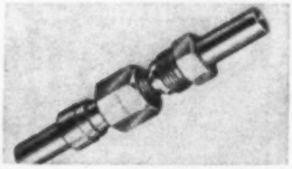
PHOTOMETRIC ANALYZERS



New line of Photometric Analyzers which provides simple, reliable analysis of absorption in the region from 2100 A in the ultra-violet out to $3\ \mu$ in the infrared, includes Series 500, used to measure small quantities of water in various hydrocarbons; the Series 600 that can be used to monitor a large number of materials, which absorb in the visible or ultra-violet; and the Series 350 Oxygen Analyzer (illustrated).—*Analytic Systems Co., 980 N. Fair Oaks Ave., Pasadena, Calif.*

CIRCLE 285 ON READER-SERVICE CARD

THREADED UNION



New Threaded Union with a prepositioned brazing ring inside the socket, provides a semi-permanent, brazed tubing joint to assure nonleak connections for high-pressure service. Offered in steel and stainless steel, for tubing from ¼" through 2" OD. Catalog Sheet 4375A-20 gives details.—*Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.*

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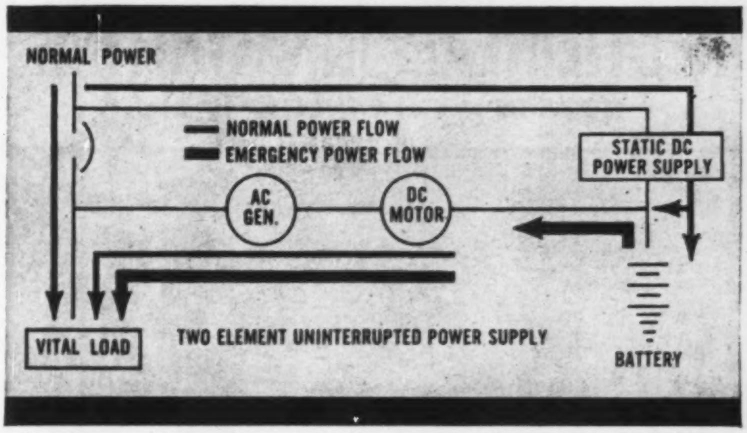
Kearfott Uninterrupted Power Systems . . .

FOR CONTINUOUS, UNVARYING POWER AT ALL TIMES



Typical applications: *Nuclear Reactors* ▪ *Power Distribution* ▪ *Digital Computers* ▪ *Process Control* ▪ *Communication Systems*

Kearfott Uninterrupted Power Systems are vital in applications where any interruption in AC power can cause serious loss or delay. These continuous power systems, which can be tailored to a variety of requirements, put an end – once and for all – to the problem of varying or intermittent prime power.

In one representative system arrangement, an AC generator is driven by a DC motor which derives power from a regulated rectifier in parallel with a long-life storage battery. When power fails or varies the rectifier, which normally supplies power to the DC driving motor, is disconnected and the battery provides surge-free power to the motor–*in zero time*. When prime power is restored, the system automatically reverts to standard operating conditions and the battery is restored to readiness by the main battery charger.

Also available in 2 and 3 unit systems operating in parallel with or isolated from the line, Kearfott's compact uninterrupted power systems also provide audible and/or visual alarms to indicate over- and under-voltage, overload or ground conditions.

Generator ratings to
150 KVA 60 and 400 cycles,
single and polyphase.

Frequency, voltage, and
transfer regulation as
required by the application.

For complete data on the wide variety of arrangements available, write to:

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

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MASSA RECORDERS
ONLY SOURCE FOR
HIGH SPEED
RECTILINEAR INK WRITING
NOW IN 4 CHANNEL — 40 MM

MORE DATA
PER DOLLAR

MASSA
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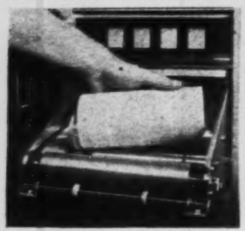
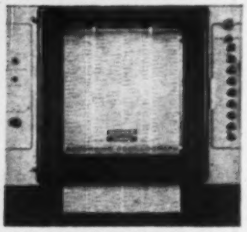
RECORDING OSCILLOGRAPH


Convenient, instant chart paper reloading from front of recorder.

Easy threading of chart paper to internal take-up roll for data storage.


Alternately, chart paper may feed out from front as shown.

All of the exclusive features incorporated in previous Massa Recorders, including the *New Controlled Linearity Oscillographs*, are incorporated in the NEW 4 CHANNEL RECORDING SYSTEM. The all new front design greatly simplifies chart paper loading and permits full instant view of pen action and recorded signals on 7" x 10" writing table. Improved tracking, instant loading, accurate performance, are some of the novel features included in the new design.

Other features: 40 mm (full scale) Oscillographs, DC to 120 cps • Ink or electric rectilinear writing • 18 chart speeds, from 0.5 cm/hr to 20 mm/sec • Event Marker • Automatic warning light for low chart indicator.

The new 4 channel recorder is now available in complete recording systems including individual transistorized driver amplifiers and power supplies for each channel, and a choice of interchangeable plug-in preamplifiers including DC, AC, Carrier and Chopper.

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A DIVISION OF
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ELECTRONICS, INC.
9 FOTTLER RD.
HINGHAM, MASSACHUSETTS

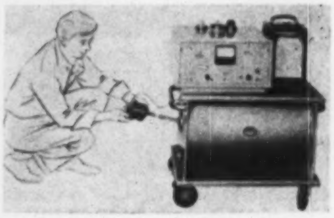
OTHER MASSA PRODUCTS

COMPLETE LINE OF
MULTICHANNEL AND PORTABLE RECORDING SYSTEMS

ACCELEROMETERS
HYDROPHONES
MICROPHONES
AMPLIFIERS
SONAR TRANSDUCERS

CIRCLE 130 ON READER-SERVICE CARD

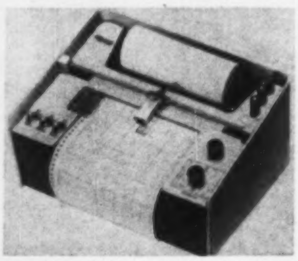
RADIOACTIVITY DETECTOR



New Fluid Monitoring System that detects and measures radioactivity in gas or water provides the large volume required for detection at MAC (maximum acceptable concentration) levels. System consists of a mobile 30-lit chamber (FMS-1), logarithmic count ratemeter (LCRM-2M) with built-in bell and alarm lights, and portable Esterline-Angus recorder.—*Nuclear Measurements Corp.*, 2460 *N. Arlington Ave., Indianapolis* 18, *Ind.*

CIRCLE 287 ON READER-SERVICE CARD

GRAPHIC RECORDER



New Graphic Recorder, Model JY-120, provides a span of 1 mv full scale and recording voltages as small as 0.001 mv. Unit has a maximum signal source resistance of 50 Kohms. Standard features include a pen speed of ½" full scale, accuracy of ½% of span limit of error, and step selection of ranges up to 10 v by means of an attenuator on the front panel. Chart width: 5".—*Nesco Instruments, Inc.*, 638 *W.* 17*th St., Costa Mesa, Calif.*

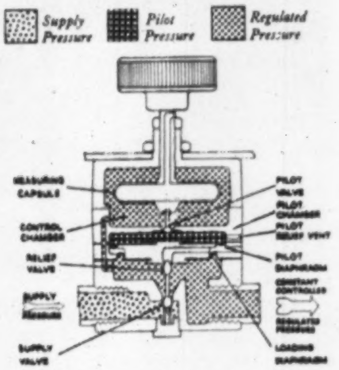
CIRCLE 288 ON READER-SERVICE CARD

TEMP-MONITOR SYSTEM

New Type-Z Temperature-Monitor System, especially suited for refrigerated and air-conditioning buildings with range from −50° to +300° F, has switches on the main panel for calibration and room selection and a confirming indicator light being mounted nearby. Temperature indication is accurate to ±1% of scale reading.—*Royco Instruments, Inc.*, 365 *San Antonio Rd., Mountain View, Calif.*

CIRCLE 289 ON READER-SERVICE CARD

PRESSURE REGULATOR


▨ Supply Pressure
■ Pilot Pressure
▨ Regulated Pressure
MEASURING CAPSULE
CONTROL CHAMBER
RELIEF VALVE
SUPPLY PRESSURE
SUPPLY VALVE
PILOT VALVE
PILOT CHAMBER
PILOT RELIEF VENT
PILOT DIAPHRAGM
CONSTANT CONTROLLED
REGULATED PRESSURE
LOADING DIAPHRAGM

New Pressure Regulator, Fig. I, uses the lower regulated pressure for pilot energy, feeding it through a high-gain servo system in which the main valve action is controlled by a pilot nozzle. The result is low air consumption, precise control, and instantaneous response, even when there are wide variations in supply pressure.—*Lexington Controls, Inc., Box 132-J, Burlington, Mass.*

CIRCLE 290 ON READER-SERVICE CARD

AN/DIG CONVERTER

New AN/DI, a solid state analog-to-digital converter which performs 3000 conversions/sec, is compatible with the analog signals produced by existing types of industrial and military transducers, and converts these voltages into three decimal digits in digital-code format. Accuracy is 0.1% ± 5 mv.—*Moore Associates, Inc., 2600 Spring St., Redwood City, Calif.*

CIRCLE 291 ON READER-SERVICE CARD

WELL TESTING SYSTEM

New Well Testing System, Model WT-300, automatically tests 25 or any multiple of 25 oil wells. Outstanding features include purge timer, test timer, and skip-test well selector switches; oil-, gas-, and water -counters for tabulation and storage of data during test; etc.—*Instruments, Inc., Box 556, Tulsa, Okla.*

CIRCLE 292 ON READER-SERVICE CARD

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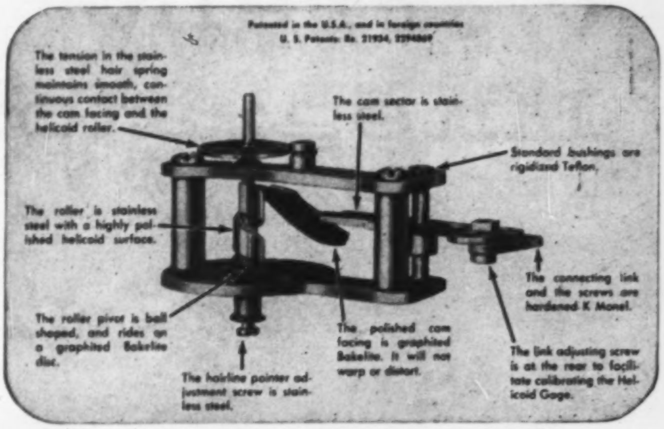
Gage
U.S.A.


Patented in the U.S.A., and in foreign countries
U. S. Patents: Re. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is stainless steel.
Standard bushings are rigidized Teflon.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides...
Sustained Accuracy... on the toughest jobs

- **Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.**

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

WRITE for details

Ask for Catalog DH-65

HELICOID GAGES

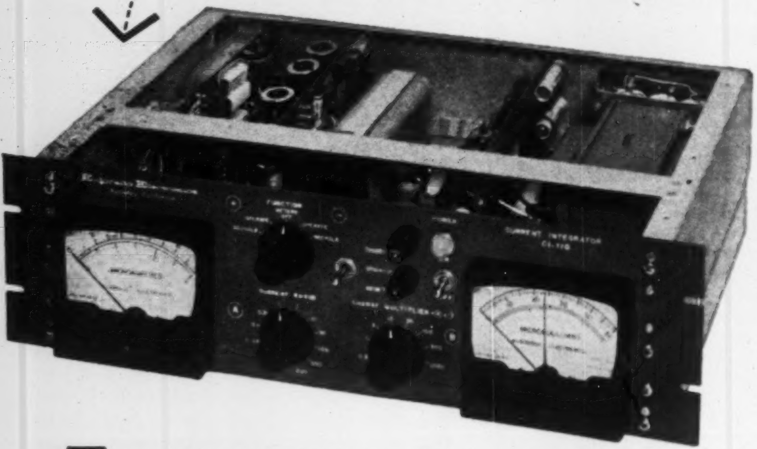
Helicoid Gage Division • American Chain & Cable Company, Inc.
929-B **Connecticut Ave., Bridgeport 2, Conn.**

ACCO

CIRCLE 131 ON READER-SERVICE CARD

New Current Integrator

A Versatile Tool for the Scientist and Process Control Engineer



ELDORADO's Model CI-110 Current Integrator measures the instantaneous value of an input current (or voltage) and simultaneously integrates this input with respect to time. Featuring high accuracy, the unit includes a relay to actuate external controls when a pre-determined charge level is reached. Drift is negligible.

APPLICATIONS—Any physical parameter which can be converted to an electrical current can be measured and totaled with respect to time. Applications include: measuring beam current and total charge of a particle accelerator beam; control exposure in photographic processing to eliminate the effect of brightness changes; to accurately deposit a given thickness in electroplating; to make precision measurements of magnetic flux; to replace chemical coulometry; and in other comparable fields.

KEY SPECIFICATIONS

CURRENT RANGE	3×10^{-9} to 10^{-3} amperes dc
INTEGRATING CAPACITY	Up to 50 coulombs
ACCURACY	±0.2% (current) ±0.8% (charge)
INTEGRATION TIME	Up to 16 hours for rated accuracy

For more details, write for technical bulletin. Please address Dept 54.

Eldorado Electronics
2821 TENTH STREET, BERKELEY 10, CALIFORNIA

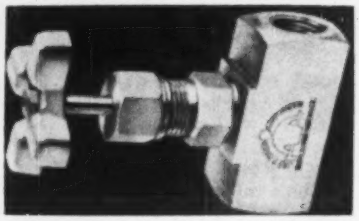
CIRCLE 132 ON READER-SERVICE CARD

MINI CONTROL SYSTEM

New miniature Electronic Control System, the M-Line Temperature Control Loop, provides all of the required instrumentation to measure and control a furnace. Instruments used in the loop include: a temperature transmitter; single-pen Speedomax M recorder; a control system using a controller, set-point unit and auto-manual station; and a magnetic amplifier.—*Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.*

CIRCLE 293 ON READER-SERVICE CARD

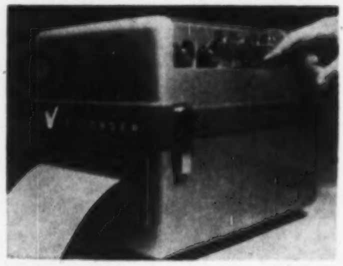
NEEDLE VALVES



New 316 S.-S. Needle Valves, Series 1936, provide precision throttling and tight shut-off at any pressure through 6000 psig. Available in globe and angle patterns and in panel mounted types; sizes ⅛", ¼", ⅜", ½", ¾" and 1".—*Marsh Instrument Co., Div. of Colorado Oil and Gas Corp., Skokie, Ill.*

CIRCLE 294 ON READER-SERVICE CARD

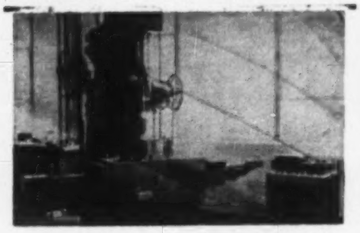
LOW-COST OSCILLOGRAPH



New 1406 Visicorder, a direct-recording Oscillograph, records up to six simultaneous dynamic functions and produces instantly readable permanent records without inks, styli, heat, powders, or chemical processing. —*Minneapolis-Honeywell Heiland Div., 5200 East Evans Ave., Denver 22, Colo.*

CIRCLE 295 ON READER-SERVICE CARD

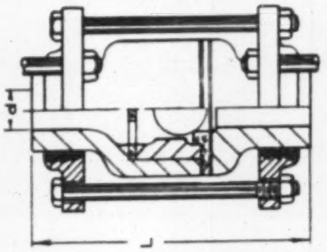
NUMERICAL CONTROL SYSTEM



New Numerical Control System features production accuracy of up to ± 0.0002 on a 40-inch work table. Modular components include a tape reader, distributor, digital analog converter, notch phase discriminator, mechanical module, position indicator control, and servomicrometer. Bulletin gives details.—*Diehl Mfg. Co., Somerville, N. J.*

CIRCLE 296 ON READER-SERVICE CARD

CHECK VALVES



New Porcelain Check Valves, incorporating a flanged porcelain body, a guided porcelain cone, or alumina ball check (illustrated), and a Teflon seat, are recommended for up to 150 psig pressure and are available in sizes from ½" to 3". They are inert to the action of most chemicals. The solid porcelain body is unaffected by all acids except hydrofluoric and hot concentrated phosphoric.—*Lapp Insulator Co., Process Equipment Div.,* 121 *Hall St., LeRoy, N. Y.*

CIRCLE 297 ON READER-SERVICE CARD

OSCILLATOR TRANSDUCER

New Miniature Sub-Carrier Oscillator Transducer, Model TP 54, combines, in a single package, a variable reluctance transducer with a transistorized oscillator for FM output. Available in ranges from 0-15 to 0-5,000 psi, gage and absolute, with output frequency deviation of ±7½% about center frequency. Output voltage is 3 to 5 v across a 10 k load.—*Pace Engineering Co.,* 13035 *Saticoy St., North Hollywood, Calif.*

CIRCLE 298 ON READER-SERVICE CARD

Gardsman by WEST

TEMPERATURE CONTROLLERS

serve your need Best

General characteristics: indicating *and* providing positive control; distinctively simple, convenient, reliable, economical; tubeless; plug-in meter units; thermocouple break protected; guaranteed; demonstrated and serviced from offices in many cities here and abroad.

0
2
4
6
8
WEST
Gardsman
WEST

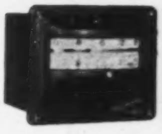
MODEL J SERIES

for Off-On control

MODEL JP SERIES

for **Proportioning** control; more precise where heating-cooling factors are more dynamic

MODEL JL SERIES

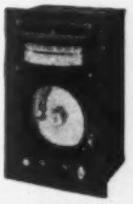


combines **High Limit** and **Off-on** control

MODEL JE SERIES

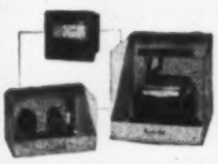
Portable—ideal for laboratories

MODEL JG SERIES



provides **Program** control, applying any of above control actions to control both time and temperature.

MODEL JSC SERIES



gives **Stepless control; extremely precise**

MODEL JT SERIES

gives **3-Position** control for motorized valves, 3-phase heating, heating-cooling cycles

All controllers can be furnished for thermocouples or resistance bulbs. For data on these or other West instruments and accessories, use your classified phone directory or write direct.

the trend is to **WEST**

WEST *Instrument* **CORPORATION**

SALES OFFICES IN PRINCIPAL CITIES

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Represented in Canada by Upton, Bradeen & James

CIRCLE 133 ON READER-SERVICE CARD

New...
Davis
Paramagnetic
OXYGEN
Analyzer
MODEL 11-4500

1. Selective to oxygen. Measures oxygen content of gases.
2. Simple non-electronic circuit.
3. Rugged glass-coated, corrosion-resistant filaments in plastic measurement cell, with constant temperature housing.
4. Fast response—95% reading in 15 seconds.
5. Simple pressure compensation.
6. Available in:
   - a) Standard or explosion-proof construction.
   - b) Five-inch scale indicating meter. Alarm contact and relay optional, also conventional electronic recorder controllers.
   - c) Floor standing cubicle or panel-mounted cabinets.
7. Ranges from 0 — 5% O_2 to 0 — 100% O_2.

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS
Division of Davis Emergency Equipment Co., Inc.
80 Halleck Street, Newark 4, N. J.
In Canada: Levitt Safety Ltd., 747 Vaughan Road, Toronto

CIRCLE 134 ON READER-SERVICE CARD

MACHINE-DIVIDED SCALES

Made with latest SIP Swiss Automatic Dividing Machines

LINEAR
Accuracy to ±5 microns (0.0002")
CIRCULAR
Accuracy to ±5 seconds

Any scale pattern—Any line width—Any material

FINE MACHINE ENGRAVING
Scales, Dials, Drums, Rods, Panels

ACCURATELY ETCHED RETICLES
Made in any specified pattern and dimensions

PRECISION MACHINE-RULED MASTERS
For printed circuits, i.e., commutators, switches, and general circuitry

L. C. RENICK CO.
308 So. Salsipuedes St., Santa Barbara, Calif.
formerly Cicero, Illinois

CIRCLE 135 ON READER-SERVICE CARD

PRECISION PLATINUM THERMOMETERS

MODEL 150B
MODEL 162A
MODEL 134D

Illustrated Models

MODEL 162A Working standard thermometer. Stability is 0.01 C° over most of range from -182 C° to +260 C° (other models to -265 C° on request). Available on fast delivery.

MODEL 150B Miniature liquid hydrogen probe. The diameter is only 0.160 inches.

MODEL 134D Liquid oxygen probe. Widely used for Missile applications. High stability.

Write for New Catalog No. 115811 for description of 50 different REC probes, including total temperature probes and surface probes.

REC
ROSEMOUNT ENGINEERING COMPANY
4902 West 78th St.
Minneapolis 24, Minn.

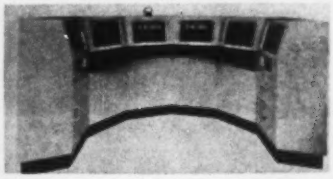
CIRCLE 136 ON READER-SERVICE CARD

BALL VALVES

New line of Ball Valves, made of the toughest grade of Type I, unplasticised polyvinyl chloride meets the proposed new ASTM specification. It can be heat welded, or solvent bonded right in the line for maximum integrity, and features full flow when open and leak-tight performance when closed. Sizes are ½", ¾", and 1", all NPT female connections. —*Hoke Inc., 1 Tenakill Park, Cresskill, N. J.*

CIRCLE 299 ON READER-SERVICE CARD

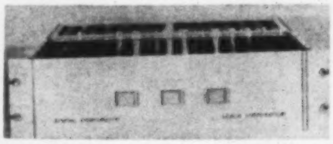
BRIDGE CONSOLE



New High Precision Bridge Console, Type BC-101, for comprehensive audio-frequency checks, features measurement of impedance from 20 micro-ohms to thousands of megohms, to an accuracy of 0.01%. Comparisons of impedances can be made to an accuracy of 0.001%. The console can be fitted with Wayne Kerr instruments best-suited to individual requirements, ranging from four to six units.—*Wayne Kerr Corp., 1633 Race St., Phila. 3, Pa.*

CIRCLE 300 ON READER-SERVICE CARD

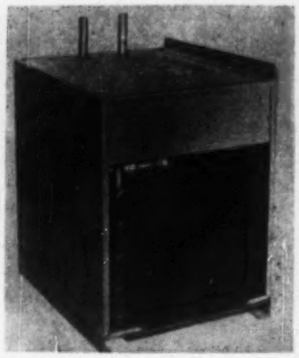
DIGITAL COMPARATOR



New programmable Digital Comparator, capable of comparing measurement numbers at rates as high as 100,000/sec, using solid-state circuitry throughout, accepts digital information from an analog-to-digital converter, as an example, and compares it with preset high and low tolerance limits. It then gives the correct answers in terms of Go, No-Go-Hi, or No-Go-Lo.—*Leach Corp., 5915 Avalon Blvd., Los Angeles 3, Calif.*

CIRCLE 301 ON READER-SERVICE CARD

AIR DRYER



New low-cost Series-E Air Dryer has a rated capacity of 10 scfm at 100 psig, making it ideally suited for air conditioning and ventilating control systems, printing press and other pneumatic feeds, processing and production lines, and many laboratory applications. Unit dries air and gases by mechanical refrigeration. No cooling water is needed. Details in bulletin.—*Hankison Corp., Canonsburg, Penna.*

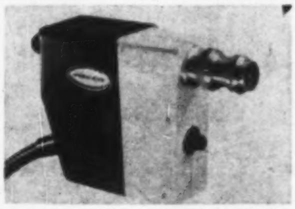
CIRCLE 302 ON READER-SERVICE CARD

SPRING SET SOLENOID RELEASED BRAKE

New spring-set, solenoid released Brake Unit, Style "H" 44, for 40-frame motors, with a torque rating of 3 ft-lb is available for ac and dc and with drip-proof enclosure. Higher-torque rated unit is ideally suited for use in small hoists, weighing devices, etc.—*Stearns Electric Corp., 120 North Broadway, Milwaukee 2, Wis.*

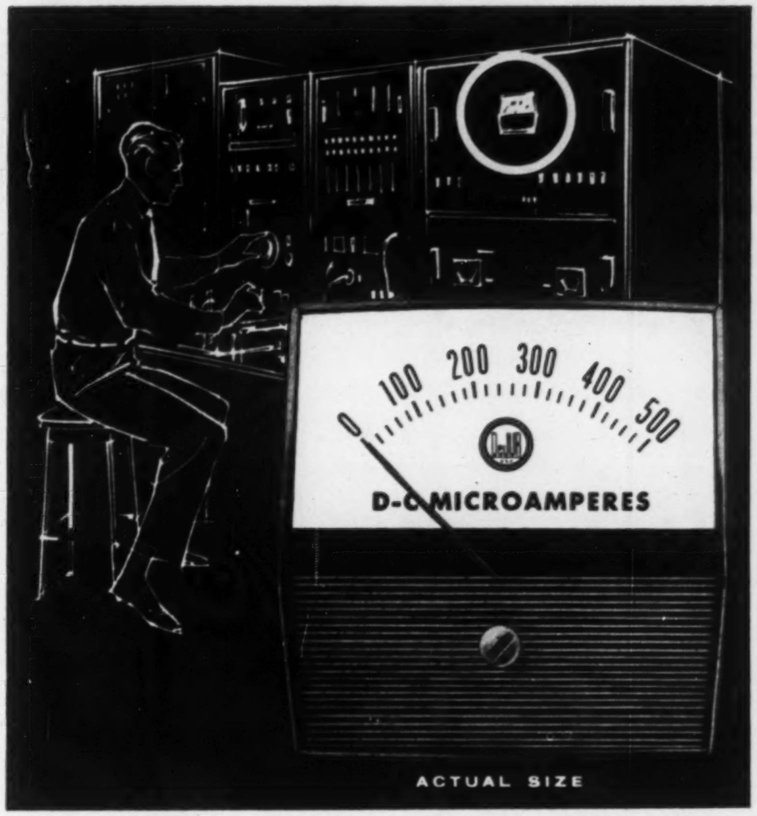
CIRCLE 303 ON READER-SERVICE CARD

OPTICAL PYROMETERS



New 2-color Optical Pyrometers, Pyro-Eye, for completely automatic, continuous measurement and control of temperature in the ranges from 1400°F to 4500°F and from 750°C to 2500°C, available in two models: one for fixed mounting in production areas; the other, portable for laboratory use; measure temperatures at any distance from 20" to 60' from the target. Identified as 2-color pyrometers, they measure temperature of an incandescent object as a function of the difference between the object's radiant energy at two narrow-band wavelengths within the visible spectrum.—*Instrument Development Labs., Inc., Attleboro, Mass.*

CIRCLE 304 ON READER-SERVICE CARD



ACTUAL SIZE

New Panel Meters by DeJUR

Offer Improved Reliability and Readability

Now, DeJur has designed high precision and complete reliability into a standard, off-the-shelf panel meter for original equipment and replacement applications. A wide arc scale plate combined with the modern, streamlined case provide improved readability and attractive appearance. These internal core magnet units develop greater torque and are self-shielding. Model 25 instruments are available as DC and AC Microammeters, Milliammeters, Ammeters and Voltmeters . . . **these units soon available through your distributor.**

SPECIFICATIONS

ACCURACY .... ±2% of Full Scale
CALIBRATION .... Mounts on Panel of Any Material
SCALE .... 2⅛" Long
ZERO ADJUSTER .... External
POINTER .... Lance (other shapes on order)
TERMINALS .. Threaded stud type, #8-32
MOUNTING HARDWARE ..... Three 4-40 nuts and three #4 lockwashers supplied
CASE .... Plastic, not sealed
MOUNTING DIMENSIONS ... 3-Hole per ASA – C39.1
EXTERNAL MAGNETIC EFFECT ..... NIL

Write for detailed literature on complete lines

You're always sure with

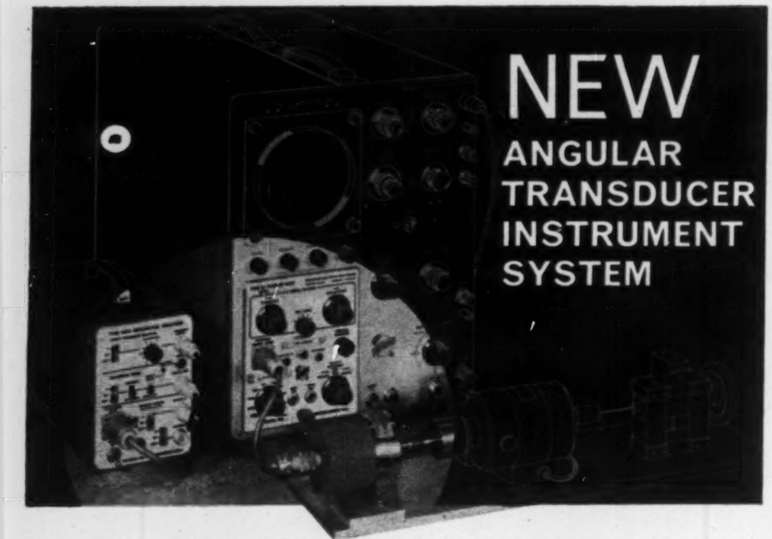
DeJUR

ELECTRONIC COMPONENTS

ELECTRONICS DIVISION
DeJUR-AMSCO CORPORATION
45-01 NORTHERN BOULEVARD
LONG ISLAND CITY, N. Y.

Manufacturers of Precision Electronic Components for Over 35 Years

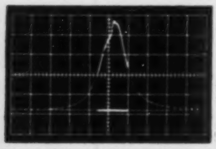
CIRCLE 137 ON READER-SERVICE CARD



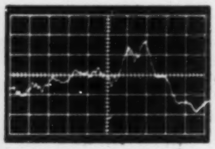
Instrumentation for the wheel-balancing application shown includes the two units of the ROTAN system—Type 182A Angle-Encoding Transducer and Type 183A Rotational Analyzer—working in conjunction with a linear variable differential transformer and a Type Q Plug-In Unit in a Type 533 Oscilloscope.

A Type 182A Angle-Encoding Transducer and a Type 183A Rotational Analyzer comprise the new Tektronix ROTAN system. Designed to study rotation-associated phenomena in machinery, the two ROTAN units adapt an oscilloscope to provide horizontal trace deflection proportional to angular displacement of a rotating shaft. The ROTAN system generates a horizontal sweep representing shaft angle—at speeds from essentially zero to 20,000 rpm. Transduced data, such as velocity, pressure, acceleration, or vibration (applied to the oscilloscope vertical input), appears on the crt screen correctly referenced to this instantaneous angular position.

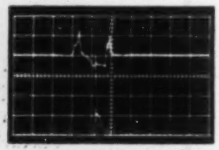
TYPICAL ROTAN DISPLAYS



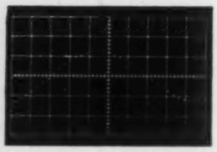
Diesel engine cylinder pressure *vs.* crank angle. 360° display with 10° intensity markers. Intensified portion is the 50° sector covered by the main sweep, starting at 160°.



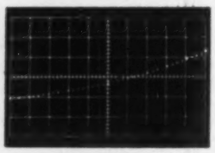
Vibration *vs.* crank angle. 360° display of a 4-cycle, 1-cylinder gasoline engine.



Ignition *vs.* crank angle. 360° display with 10° intensity markers. The upper trace is the secondary voltage and the lower trace is the secondary current.



Bearing housing displacement *vs.* angular shaft position—wheel balancing application. *Left:* a normal trace, 360° rotation of the wheel, 10° intensity markers. *Right:* a magnified trace, 1° intensity markers. Amplitude designates the amount of wheel unbalance. Peak designates the point of unbalance.



Price, ROTAN System. . **$850.00**
(f.o.b. factory)

Call your Tektronix Engineer for a demonstration of the ROTAN system in your own application.

Tektronix, Inc.

P.O. Box 500 • Beaverton, Oregon • Phone Mitchell 4-0161 • TWX—BEAV 311 • Cable: TEKTRONIX

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex. • Atlanta, Ga. • Baltimore (Towson, Md.) • Boston (Lexington, Mass.) • Buffalo, N.Y. • Chicago (Park Ridge, Ill.) • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio • Denver, Colo. • Detroit (Lathrup Village, Mich.) • Endicott (Endwell, N.Y.) • Greensboro, N.C. • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission, Kan.) • Los Angeles, Calif. Area (East L.A. • Encino • West L.A.) • Minneapolis, Minn. • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N.J.) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale, Ariz.) • Poughkeepsie, N.Y. • San Diego, Calif. • San Francisco (Palo Alto, Calif.) • St. Petersburg, Fla. • Syracuse, N.Y. • Toronto (Willowdale, Ont.), Canada • Washington, D.C. (Annandale, Va.)
TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington.
Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please write Tektronix Inc., Victoria, Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.

CIRCLE 138 ON READER-SERVICE CARD

TEMPERATURE INDICATOR

New BH180 AutoTemp is a 50-point digital Temperature Indicator. By pushing the appropriate button the instrument gives the temperature at that point.—*B&H Instrument Co., Inc., Fort Worth, Tex.*

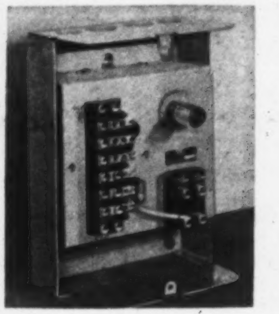
CIRCLE 305 ON READER-SERVICE CARD

DIGITAL MICRODIAL

New 1330 Series Direct-Reading Digital Microdial counts from 000 through 999 in exactly ten turns. Overall size is 1¾" dia x 1¾" height. Numerals are 3/16" high.—*Borg Equipment Div., Amphenol-Borg Electronics Corp., 120 South Main St., Janesville, Wis.*

CIRCLE 306 ON READER-SERVICE CARD

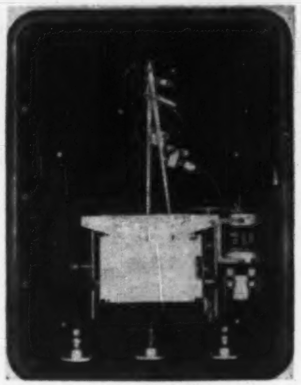
LIQUID LEVEL CONTROL



New high-sensitivity electronic Floatless Level Control, Type 50-201, features positive fail-safe operation. Typical materials on which the control can be used are ordinary and deionized water, alcohol, glycols, and anhydrous ammonia, as well as bulk materials having low moisture content.—*B/W Controller Corp., 2200 E. Maple Rd., Birmingham, Mich.*

CIRCLE 307 ON READER-SERVICE CARD

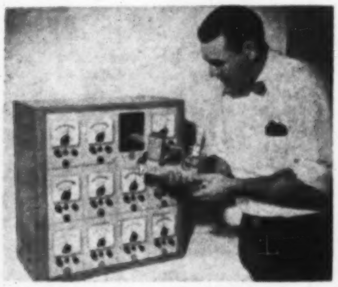
STRIP CHART RECORDER



New Strip Chart Recorder is equipped with a cartridge, (including chart, storage spool and rewind spool) which is removed as a unit, so that chart changes can be made in a few seconds. Records of flow, pressure and temperature measurements are provided for periods up to 36 days without attention.—*American Meter Co., 920 Payne Ave., Erie, Pa.*

CIRCLE 308 ON READER-SERVICE CARD

TEMP CONTROL PANEL



New Temperature Control Panel has interchangeable modules, each a complete plug-in temperature control built around a contact meter-relay. It triggers alarms when temperatures exceed their desired limits during testing of nuclear materials.—*Assembly Products, Inc., Chesterland, Ohio.*

CIRCLE 309 ON READER-SERVICE CARD

INFORMATION SYSTEM

New solid-state Digital Information Systems, designated Bailey 750, is modularized and features magnetic-drum programming. It continuously measures and scans 110 variables including currents, voltages, power, and gate positions. Variables are scanned at the rate of one per sec and all points are logged out once an hour or upon demand. High and low set points may be programmed for any of all variables so that an off-normal condition will actuate both a visual and audible signal.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*

CIRCLE 310 ON READER-SERVICE CARD

MEASURE ABSOLUTE PRESSURES

with SPEED and PRECISION

With Wallace & Tiernan Aneroid Dial Indicators you get precision and fast response in all types of absolute pressure work.

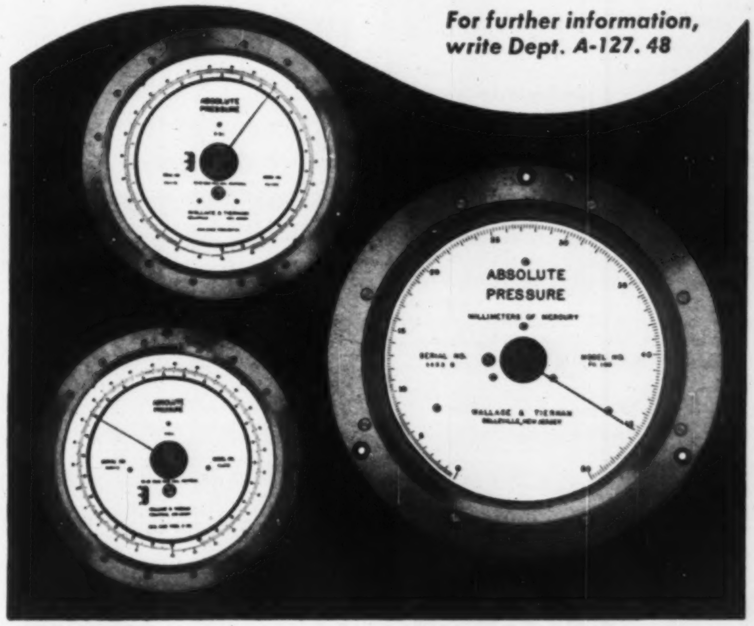
W&T Precision Indicators have many uses in research and development engineering. One is ideal for calibrating pressure transducers; another, for checking the calibration of flight instruments and ground support equipment. These instruments also keep constant check on continuous production-line work.

A W&T Absolute Pressure Gauge on the job means:

- ★ Accuracy 0.1% to 0.33%
- ★ Sensitivity 0.01% to 0.2%
- ★ Range 0.1-20 mm Hg to 0-500 p.s.i.a
- ★ No corrections
- ★ Light weight, small size

The accuracy of W&T Absolute Pressure Indicators approaches that of liquid columns... higher sensitivity assures faster response... large dial gives quick reading.

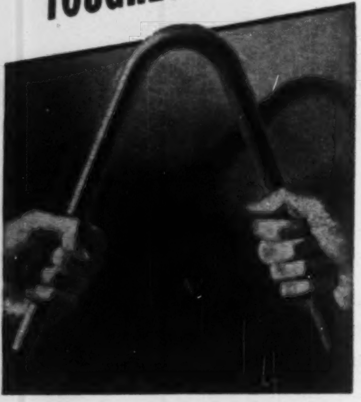
For further information, write Dept. A-127. 48



WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CIRCLE 139 ON READER-SERVICE CARD

TUBING THAT KEEPS ITS TEMPER IN THE TOUGHEST SPOTS



PRECISION TUBING

Made To Your Product Requirements . . . Sold At Regular Prices

The right temper in tubing can mean the difference in finished product quality. It should be varied to meet the job to be done.

Precision Tubing can be produced to meet your most exacting specifications from annealed to full hard. Continuous hydrogen atmosphere and combusted gas atmosphere bright annealing furnaces, scientifically controlled by advanced instrumentation assures the correct temper in every foot of tubing . . . locked in for the life of the tubing.

Precise temper is only one of the outstanding qualities of Precision Tubing. Accuracy, mirror-finishes, quick deliveries and regular mill prices are all offered in Precision Tubing . . . in copper, brass, bronze, nickel, nickel-alloy . . . sizes .010" to 1.125" O.D. in all shapes. Get the full details, write for catalog to

PRECISION TUBE CO., INC.
North Wales, Pa.

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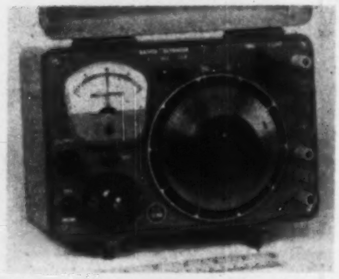
PRECISION
TUBE COMPANY
PRECISION-EERS OF SMALL TUBING

CIRCLE 140 ON READER-SERVICE CARD

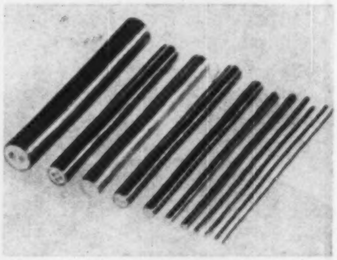
STRAIN INDICATOR



New portable, completely transistorized Strain Indicator, Model HW-1, requires no phase balance adjustment to maintain sensitivity and accuracy, even when very long leads are used between instrument and strain gages. Total Strain range is 60,000 min/in, gage factor range is 1.5 to 4.5. Sensitivity is better than 1 min/in. Can be used with all resistance-type strain gages having nominal resistance from 50 ohms to 2,000 ohms. Overall dimensions are 6" x 9" x 6" high.—*Strainsert Div., of Polyphase Instrument Co., Bridgeport, Penna.*

CIRCLE 311 ON READER-SERVICE CARD

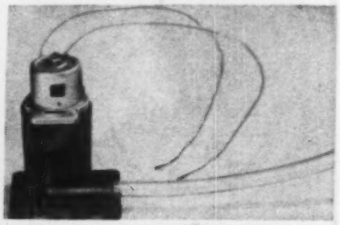
SHEATHED THERMOCOUPLES



New line of metal-sheathed thermocouples, a durable combination of sheath, wires, and ceramic insulation, features accuracy within the recommended ISA limits. Obtainable in a variety of configurations and standard cold end terminations.—*Harco Laboratories, Inc., New Haven, Conn.*

CIRCLE 312 ON READER-SERVICE CARD

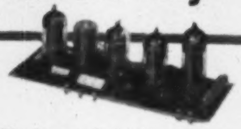
MINIATURE WATER PUMP



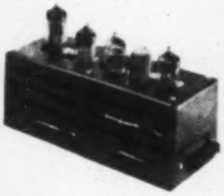
New Electric Motor and Water Pump combination measures only 2⅝" x 1¾". Flow rate of water is 1 pint/min at a 12" head. With two D-batteries in series, it will pump to 24" high. Pump works in either direction. —*Edmund Scientific Co., Barrington, N. J.*

CIRCLE 313 ON READER-SERVICE CARD

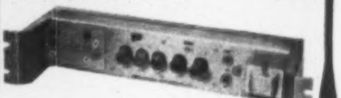
You can look at Philbrick's USA-3 Amplifier at least 3 ways



1. Undressed — Here's the basic unit itself — more performance per dollar than any other operational amplifier. Highly reliable — no electrolytic capacitors or glow tubes. Designed to prevent self-destruction, even when output is grounded. Drift, noise, offset under 100 microvolts. Output, ± 115 vdc. Wide frequency range — dc to 100 kc (attenuation less than 3 db) when connected as gain-of-ten amplifier. Printed circuit board, 7" x 2½". Price, 1 to 9 units: $95



2. Dressed — In a neat 3" x 7½" ventilated aluminum package, it becomes the USA-3-M3. It has sufficient room for the user to implement its operational destiny by installing additional circuit components. For example, you make it into a complete diode function generator, or integrator, or whatever you wish. The important feature of plug-in interchangeability is enhanced by the 4 to 7 spare terminals on the Blue Ribbon Connector. Price, 1 to 9 units: $125



3. Dressed-up — Now it's a full fledged utility packaged amplifier, known as the UPA-2. Combining a new level of convenience and flexibility, it is immediately operational when plugged into any Philbrick power supply. It can be made to drive a 12,000 ohm load to 100 volts in either direction. Designed for bench top use, it comes installed in a 3½" rack adapter, from which it is easily removed. The UPA-2 is ideal for analog computing, measurement and control, continuous data reduction, and many other feedback operations. Price, 1 to 9 units: $149

- OEM's: write, wire, or phone for quantity prices
- Military equivalents available
- 8 page technical manual available on request

GEORGE A.
PHILBRICK
RESEARCHES, INC.
285 Columbus Avenue, Boston 16, Mass.
COmmonwealth 6-5375, TWX: BS1032, FAX: BSN
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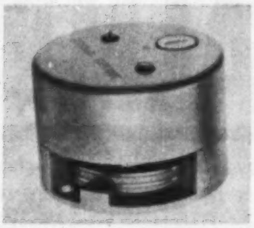
Export Office: 135 Liberty Street, New York 6, N. Y.
Tel. WOrth 4-3311, CABLE: TERMRADIO

CIRCLE 141 ON READER-SERVICE CARD

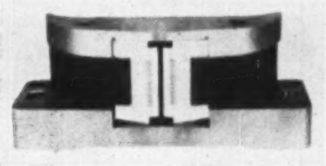
SOLENOID-RELEASED BRAKE



New spring-set, solenoid-released Brake Unit, Style "H" 44, for 40-frame motors, with a torque rating of 3 ft-lb is available for ac and dc and with drip-proof enclosure. Higher-torque-rated unit is ideally suited for use on small hoists, weighing devices, etc.—*Stearns Electric Corp., 120 North Broadway, Milwaukee 2, Wis.*
ble.

CIRCLE 314 ON READER-SERVICE CARD

MAGNETIC TAPE HEAD AND GUIDE

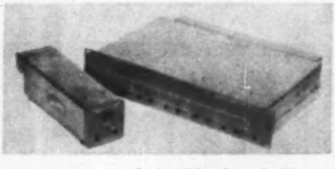


New Model DTH 2132 Digital Magnetic Tape Head is a 32-track interlaced head for 1" tape, employing a unique new core design which affords extremely high efficiency, both in record and playback of digital data. The new precision Tape Slot Guide, Model TG Series, nearly eliminates tape skew and scrape-flutter. The width of the highly polished hard chrome lot is held to the order of millionths of an inch, thus providing superior guidance while greatly reducing tape curl and wear.—*Shepherd Industries, Inc., 103 Park Ave., Nutley, N. J.*

CIRCLE 315 ON READER-SERVICE CARD

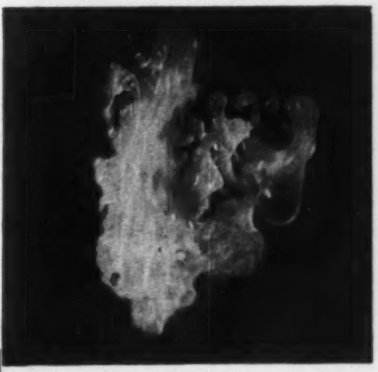
P/S FOR STRAIN GAGES

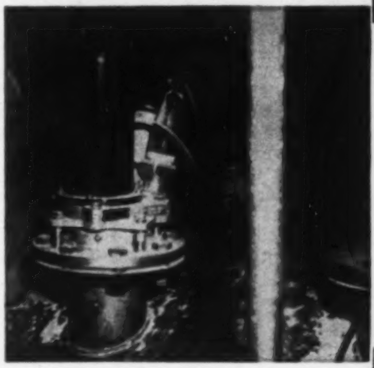
Six new standard models of transistorized Power Supplies for strain gages have continuously-variable output ranges from 0 to 30 v and 0 to 200 mamp at input of 117 v (95-135)/60 cps. Power supply noise level across a grounded 350 ohm bridge is held to 1.00 μv peak-to-peak typical. Line voltage regulation is held constant within 0.03% and load regulation within 0.03%.—*Computer Engineering Associates, Inc., 350 North Halstead, Pasadena, Calif.*



CIRCLE 316 ON READER-SERVICE CARD

YES, NOW VISCOSITY



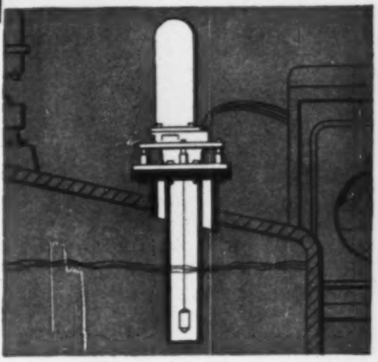


CAN BE CONTINUOUSLY

PROCESS CONTROLLED

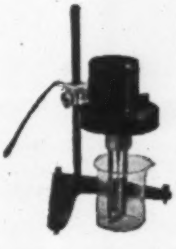
WITH THE

BROOKFIELD VISCOMETRAN



UNDER actual process conditions, the Brookfield Viscometran accurately and continuously measures, records and controls viscosity. Readily mounted and integrated in existing processes, the Viscometran offers significant economic advantages over other methods of indicating degree of reaction, degree of polymerization or determination of process end point.

Viscosity is very likely a variable that is fundamental in your process. For complete information about how the Brookfield Viscometran can provide continuous "in process" measurement of this product dimension for you, write—



THE WORLD'S STANDARD FOR VISCOSITY MEASUREMENT AND CONTROL

Brookfield
ENGINEERING LABORATORIES, INCORPORATED
STOUGHTON 316, MASSACHUSETTS

BROOKFIELD VISCOMETRANS NOW SUCCESSFULLY USED FOR CONTROLLING: Asphalt • Caramel • Cement slurries • Durezresin-acetone slurries • Gluten slurries • Lignum-based polymers • Molten P_2S_5 • Paper coatings • Polystyrene • Polyurethane resins • Ureaformaldehyde resin

CIRCLE 142 ON READER-SERVICE CARD

Small, Lightweight

MERCOID

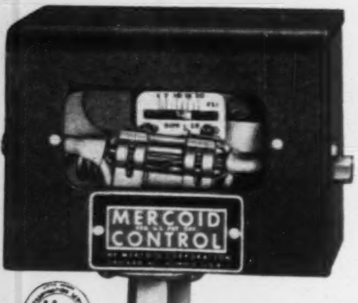
PRESSURE CONTROL

for

Instrument Air

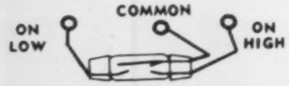
Exclusive Features

EXTERNAL ADJUSTMENT
VISIBLE CALIBRATED DIAL
VISIBLE SWITCH POSITION
FOR PANEL OR PIPE MOUNTING
SEALED MERCURY CONTACT



TYPE AP-153

ADJUSTABLE OPERATING RANGE	SWITCH DIFFERENTIAL With Pointer Set At	
	LOW	HIGH
1 to 20 psig.	0.3	0.5
1 to 30 psig.	0.4	0.75



Provides any of following operations:

1. Single Pole—Cut-in high (close on rise)
2. Single Pole—Cut-in low (open on rise)
3. Single Pole—Double Throw

OTHER TYPES AVAILABLE

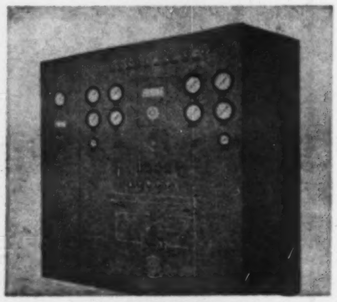
CASE: NEMA 1—Heavy gauge steel, cadmium plated. Steel cover (with glass front).

WRITE FOR BULLETIN 02

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

CIRCLE 143 ON READER-SERVICE CARD

ENGINE CONTROL SYSTEM

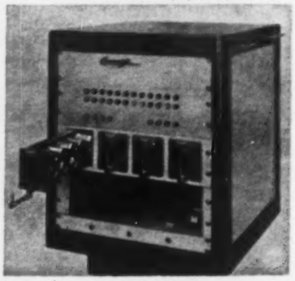


A new Pneumatic Engine Control System for automatically starting, loading, and shutting down internal combustion engines incorporates safety functions to signal or shut down the engine due to malfunction of any one of a unlimited number of measurable variables. Each system is engineered to the customer's particular requirements. Inherently explosion-proof, all measurable variables are monitored continuously. Variables include temperatures, pressures, liquid levels, vibration and engine speeds.

Sequence starting is initiated by pressing a single button which may be located on the control panel or at a remote station. If any individual function fails to reach the correct operating level, the system locks out and must be restarted from the initial stage following correction of the malfunction. Similarly, upon safety shutdown from any malfunction, the engine cannot be restarted until the cause of the shut-down (immediately identified from the annunciator position) has been corrected. Folder SF-760 gives details.—*Robertshaw-Fulton Controls Co., Fulton-Sylphon Div., Knoxville 1, Tenn.*

CIRCLE 317 ON READER-SERVICE CARD

MODULE CAGE



New transistor-digital-circuit Module Cage, Model TDC P-4, accommodates 26 plug-in modules per drawer, with four drawers available in a 5¼" high x 19" wide frame. A total of 104 TDC modules, shift-register bits or shift-register drivers may be so contained. Use of the new module cage allows a 50% increase in the amount of circuit density.—*Epsco, Inc., Components Div., 240 East Palais Rd., Anaheim, Calif.*

CIRCLE 318 ON READER-SERVICE CARD

PALMER

Mercury Actuated Dial Thermometers now in three types to suit any requirements

PALMER
°F
PATENTED

FULL 4½" DIAL FACE. Stem can be placed at any angle and case can be rotated to any readable position.

1 RIGID STEM DIAL THERMOMETER tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)

2 WALL MOUNTED DIAL THERMOMETER with flexible connecting armor. Case adjustable to easy reading position.

3 FLUSH MOUNTED DIAL THERMOMETER for panel mounting with flexible connecting armor.

ALL THREE TYPES HAVE A FULL 4½" DIAL FACE.

■ **for accuracy:** Mercury actuated . . . Compensated by Invar. Guaranteed Accurate 1 scale division. ■ **for angularity:** Can be adjusted to most readable position at any angle desired. ■ **for readability:** Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position. ■ **for interchangeability:** Also specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

PALMER

PALMER THERMOMETERS, INC.
Norwood Ave., Cincinnati 12, Ohio
MFRS. OF INDUSTRIAL LABORATORY, RECORDING AND DIAL THERMOMETERS

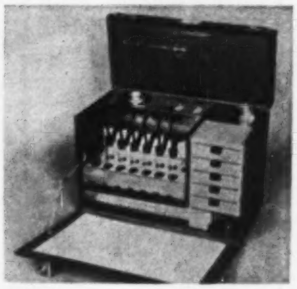
CIRCLE 144 ON READER-SERVICE CARD

A/D CONVERTER

New Transistorized Ac-Dc Multimeter/Ratiometer Analogue-to-Digital Converter, meeting MIL-P-2664-A Specs, is universally-programmable and features the capability to convert to binary coded decimal output: a-c and d-c voltages, resistance, in-phase and quadrature components of a-c voltages, ratios of a-c or d-c signals. —*Epsco Incorporated, 275 Massachusetts Ave., Cambridge, Mass.*

CIRCLE 319 ON READER-SERVICE CARD

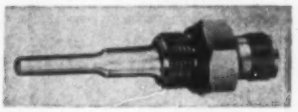
AIR POLLUTION TESTER



New portable Air Pollution Field Test Apparatus employs a colorimeter to estimate amounts of 8 gaseous pollutants and indicates presence of 10 particulate pollutants. Gaseous pollutants that can be estimated with this equipment are nitrogen dioxide, hydrogen fluoride, chlorine sulfur dioxide, oxidants, ammonia, formaldehyde, and hydrogen sulfide. Particulate pollutants that can be detected include mercury, lead copper, chromate, selenium, iron, nickel, arsenic, phosphate and sulfate.—*Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.*

CIRCLE 320 ON READER-SERVICE CARD

TEMPERATURE DETECTOR

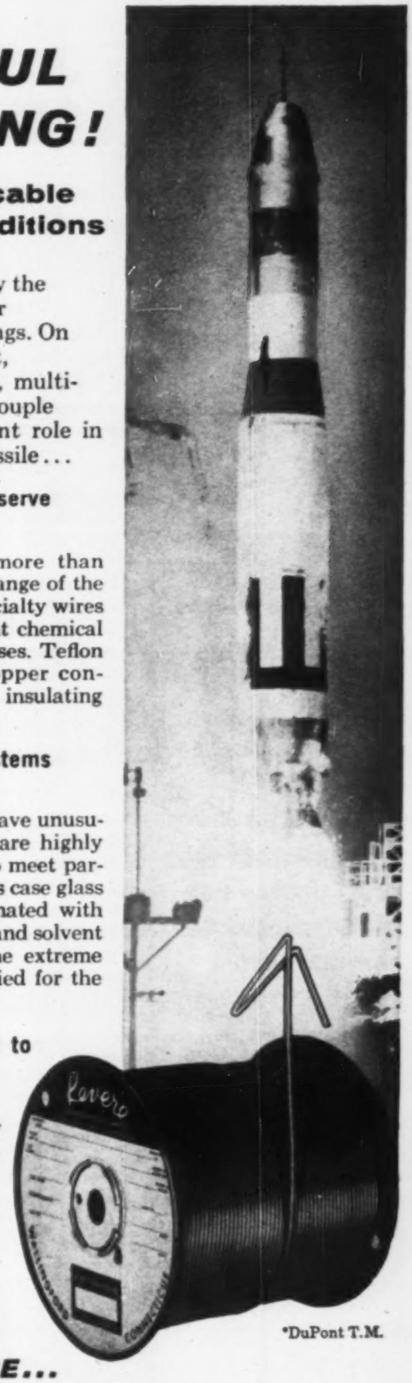


New fast-response resistance Temperature Detector, Model 249, measures the cooling water of reactors and has an exponential time constant of only 1.5 sec. Made from a single solid piece of type "R" Monel to eliminate welded joints, it has a temperature range of −70 to +200°C, and withstands radiation level of 500 rad/hr from 0°C to +170°C, radiation exposure of 5x10^7 rad total of 1 Mev average gamma radiation at temperatures of 125°C to 150°C.—*Thomas A. Edison Industries, Instrument Div., McGraw-Edison Co., West Orange, N. J.*

CIRCLE 321 ON READER-SERVICE CARD

SUCCESSFUL LAUNCHING!

REVERE wire and cable stand extreme conditions



The Titan ICBM, produced by the Martin Co., has been hailed for its series of successful launchings. On the launching pad and in flight, Revere Teflon* hook-up wire, multiconductor cables and thermocouple cables contribute an important role in successful operation of this missile...

To connect components and serve as emergency fire circuits:

Permacode®† hook-up wires more than meet the extreme temperature range of the Titan's requirements. These specialty wires provide high flexibility, excellent chemical resistance and low electrical losses. Teflon insulates the silver-coated copper conductors and impregnates each insulating jacket of the wire or cable.

To interconnect electrical systems within the missile:

Revere multi-conductor cables have unusually small diameters and thus are highly flexible. Jacketing is supplied to meet particular service conditions; in this case glass fiber braid, coated and impregnated with Teflon, gives excellent chemical and solvent resistance as well as serving the extreme range of −65 to +500°F. specified for the Titan.

To transmit temperature data to blockhouse before launching:

Revere thermocouple wire and cable provide the high accuracy required. Type supplied for the Titan uses just one of many combinations of thermocouple junctions, insulation, jacketing and shielding available from Revere to meet or exceed applicable MIL-Specs.

† Permacode is Revere's patented process for permanent color-coding of wire.

*DuPont T.M.

CALL ON REVERE...

when your project rates the best in wire and cable

Revere also supplies many other components for missile and aero-space applications.

- **Fuel System Components**
- **Molded Harness**
- **Strain Gage Load Cells**
- **Electronic Weighing Systems**
- **Glaswitch® Sealed Dry Reed Switches**

Write today for data sheets in your area of interest.

neptune

REVERE CORPORATION OF AMERICA/ *Wallingford, Conn.*
One of Neptune Meter Company's Electronic subsidiaries

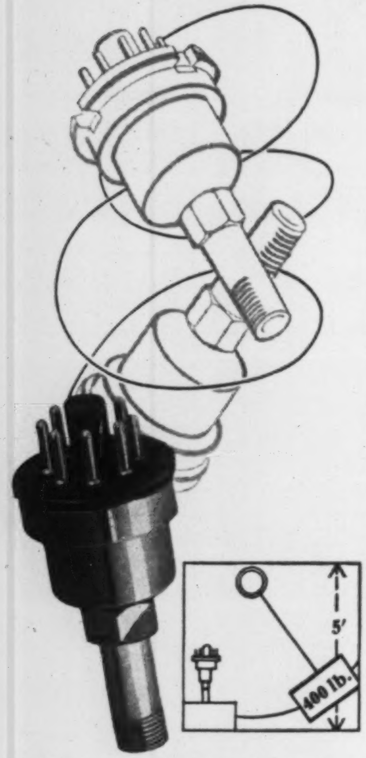
64

CIRCLE 145 ON READER-SERVICE CARD

SYNONYMS IN ACTION

rug'ged ness (rŭg'ĕd nĕs), n. strong; sturdy; hardy

Hast'ings gauge tube (hāst'ĭngs gāj tūb), n. strong; sturdy; hardy



RUGGED **HASTINGS GAUGE TUBE UNHARMED** FROM SHOCK IN 400 LB. DROP HAMMER TEST

Ruggedness is *defined as* "strong, sturdy, hardy". But ruggedness is *demonstrated* by this shock test of a Hastings Gauge Tube conducted to government specification MIL 901B. A 400 lb. drop hammer was released to apply shocks to the above pictured Gauge Tube in all three planes from 1, 3 and 5 feet. The Hastings Gauge Tube remained unharmed and fully operable.

For every application where ruggedness, plus sensitivity, is needed in the measurement of vacuum, Hastings gauges offer advantages not found in other vacuum gauges. Their special patented heated thermopile construction, compensated for temperature and rate of change of temperature, offers rapid and accurate response. Hastings direct reading gauges, free from tube burn-out or glass breakage, are available in four hard-to-measure ranges, 0-100μ Hg; 0-1000μ Hg; 0-200mm Hg and 10-200mm Hg.

Send for Free Catalog No. 175 for more information on Hastings Vacuum Gauges, Controllers, Recorders.

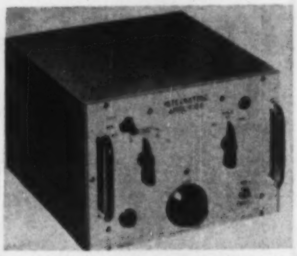
HASTINGS-RAYDIST, Inc.

1402 Newcomb Avenue,

Hampton, Virginia PArk 3-6531

CIRCLE 146 ON READER-SERVICE CARD

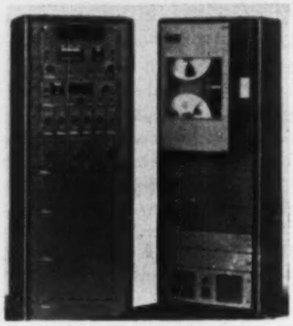
INTEGRATING AMPLIFIER



New Pye Integrating Amplifier operates from the output of any chromatograph amplifier. Display of the integrated result—integram—is usually by means of a potentiometric strip chart recorder. Flyer gives details.—*Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.*

CIRCLE 322 ON READER-SERVICE CARD

DATA RECORDING SYSTEM



New Model 10000 is a high-speed, solid-state Data Recording System for the acquisition and processing of operating and test data, featuring a highly versatile format control which produces data directly acceptable to most computers. The basic system consists of three components: a high-speed scanner in 10-channel multiples, a high-speed analog-to-digital converter, and the new output format control. Typical of the inputs which can be connected directly are thermocouples, strain gages, pressure, flow and level transducers, and analyzers of both quantitative and qualitative types.—*Electro Instruments, Inc., 3540 Aero Court, San Diego 11, Calif.*

CIRCLE 323 ON READER-SERVICE CARD

PACKAGED AIR SHOWER

New packaged Man Cleaner is designed to remove and collect dust from clothing of employees prior to their entrance to super clean areas or white rooms.—*Baker Instruments, Inc., Box 597, Chandler, Ariz.*

CIRCLE 324 ON READER-SERVICE CARD

SMALLER
(SIZE)
yet
LARGER
(C_v)
with Symmetrical Weight Distribution

Here's a complete ½" In-Line Valve with a 7.5 C_v! Springless (pneumatic or hydraulic), spring-to-open or spring-to-close operation. The operating method can be changed easily in the field without extra parts.

Write or call today for complete details on this extraordinarily compact In-Line Valve for on-off or control applications.

OTHER SIZES AND END CONNECTIONS AVAILABLE

GEORGE W.
DAHL
COMPANY, INC.
86 TUPELO STREET
BRISTOL, RHODE ISLAND
CLifford 3-9500

VALVES AND CONTROLS FOR THE COMMUNICATIONS, PROCESS AIRCRAFT AND MARINE INDUSTRIES

CIRCLE 147 ON READER-SERVICE CARD

NEW LITERATURE

VALVES

AUTOMATIC VALVE LUBRICATOR. 8-page Bulletin V-617 describes an automatic lubricator for lubricated plug valves.—Rockwell Mfg. Co., 400 North Lexington Ave., Pittsburgh 8, Pa.

CIRCLE 325 ON READER-SERVICE CARD

BUTTERFLY VALVES. 4-page supplement to Catalog 307 pictures light- and heavy-duty wafer-style valves and describes the three basic body designs (swing-through, angle-seating, or soft-seat) and shows a variety of valve actuators.—Mason-Neilan, Div. of Worthington Corp., Nahatan St., Norwood, Mass.

CIRCLE 326 ON READER-SERVICE CARD

REGULATOR AND RELIEF VALVE. 2-page brochure, Section I, illustrates and describes the 3851, Type F, pressure-reducing and relief valve.—Atlas Valve Co., 280 South St., Newark, N. J.

CIRCLE 327 ON READER-SERVICE CARD

CORROSION RESISTANT VALVES. 92-page ring binder contains dimensional sketches on globe-, angle-, gate-, check-, butterfly-valves, etc., strainers, and cocks, and engineering information on corrosion resistance.—Ladish Co., Hasco Div., Cudahy, (Milwaukee Suburb), Wis.

CIRCLE 328 ON READER-SERVICE CARD

TEMPERATURE

OXIDE PACKED THERMOCOUPLES. 4-page Bulletin F-9933 describes new line of magnesium-oxide-packed thermocouples and thermocouple wire. —Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

CIRCLE 329 ON READER-SERVICE CARD

A-C RADIATION PYROMETER. 4-page Product Specification E51-4 describes principle of operation of radiation pyrometer.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

CIRCLE 330 ON READER-SERVICE CARD

TEMPERATURE PROBES. 8-page Catalog 66030 contains illustrations, specs and descriptive material on precise platinum temperature transducers.—Rosemount Engineering Co., 4900 West 78th St., Minneapolis 24, Minn.

CIRCLE 331 ON READER-SERVICE CARD

RESISTANCE TEMP DETECTORS. 8-page Catalog 260 contains specs and sketches on more than 30 types temperature probes for aircraft and missiles; also on platinum-element temperature transducers.—Lewis Engineering Co., Naugatuck, Conn.

CIRCLE 332 ON READER-SERVICE CARD

THERMOMETERS. 8-page pocket-size brochure describes resistance thermometer, thermo-anemometer, and hydrographic thermometer.—Gelman Instrument Co., 106 North Main St., Chelsea, Mich.

CIRCLE 333 ON READER-SERVICE CARD

---

50 HOURS OR

hours for a CONTROL SYSTEM DESIGN?

esiac®

Leading aircraft and electronics firms report these startling time comparisons for designing and optimizing sophisticated 10+ pole-zero guidance systems. Comparisons were made using **Root-Locus***—ESIAC versus other computers. Figures from customer files. Details on request.

*One of many ESIAC design applications.

Graphical Techniques	More than one week required to obtain solution.	**50 hours**
Digital Computer Techniques	Extensive revision of existing root-locus program was necessary.	**30 hours**
ESIAC Root-Locus	Approximately one hour of instruction by design engineer. Assistant operated ESIAC thereafter.	**5 hours**

An entirely new concept in analog-type computer. Solves intricate system design problems in minutes instead of hours, hours instead of days. Write for descriptive engineering bulletins, ESIAC solutions to system design problems or an ESIAC demonstration in your plant.

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Impedance Bridges and Accessories
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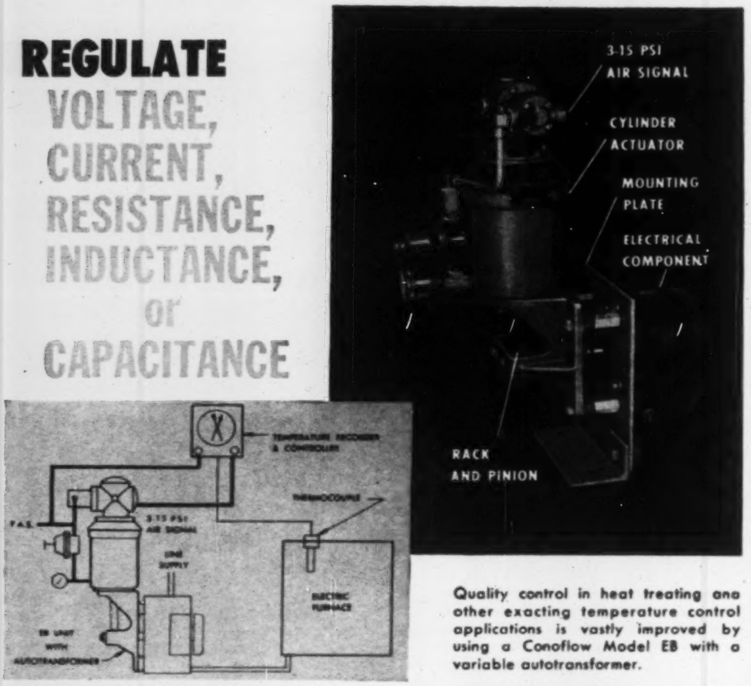

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- REWIND CONTROL
- CONSTANT FLOW
- STOKER FEED CONTROL
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ELECTRONIC TEMP CONTROLS. 2-page bulletin SIS 9000 Series describes line of electronic temperature controls.—United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.
CIRCLE 334 ON READER-SERVICE CARD

HEAT TRANSFER CEMENTS. 4-page Bulletin 600 describes the use of heat transfer cements for electric resistance heaters.—Thermon Mfg. Co., 1017 Rosine St., Houston, Tex.
CIRCLE 335 ON READER-SERVICE CARD

PRESSURE

PRECISION TEST GAGES. 12-page brochure describes Seegers Standards precision test gages.—Seegers Instrument Co., 515 West Main St., Barrington, Ill.
CIRCLE 336 ON READER-SERVICE CARD

SUB-MINIATURE STRAIN GAGE. 4-page Product Data Sheet 4330 contains drawings, graphs, tables and specs of strain gage, Type HT.—Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 42 Fourth Ave., Waltham 54, Mass.
CIRCLE 337 ON READER-SERVICE CARD

GAGES, THERMOMETERS, ETC. 6-page Bulletin 3020 describes pressure gages, thermometers, and control instruments.—United States Gauge, Div. of American Machine and Metals, Inc., Sellersville, Penna.
CIRCLE 338 ON READER-SERVICE CARD

ELECTRONIC INSTRUMENTS. 4-page brochure announces availability of complete line of EMI Electronics, Ltd., instruments, including ITV systems, batching units, high-speed oscilloscopes, high-speed weighers, and portable contamination monitors.—Fairbanks, Morse & Co., Electronics Div., 505 Oakwood Ave., West Hartford 1, Conn.
CIRCLE 339 ON READER-SERVICE CARD

DIFF-PRESS INDICATORS. 4-page Bulletin 82-M-1 provides details on Series 300 differential pressure indicators engineered specifically for LOX, filter, and fuel systems.—Industrial Instrument Corp. Drawer 777, Austin, Tex.
CIRCLE 340 ON READER-SERVICE CARD

PNEUMATIC COMPUTING RELAY. 8-page Catalog 53CR1000 describes the Sorteberg force bridge, a pneumatic computing relay.—Fischer & Porter, 547 Jacksonville Rd., Warminster, Penna.
CIRCLE 341 ON READER-SERVICE CARD

MOISTURE

MOISTURE MONITOR. 2-page Bulletin 26312 gives specs and capabilities of a type 26-312 liquid-process moisture monitor.—Consolidated Electrodynamics Corp., a subs. of Bell & Howell Co., 360 Sierra Madre Villa, Pasadena, Calif.
CIRCLE 342 ON READER-SERVICE CARD

DEWPOINT INDICATORS. 2-page Bulletin DPI-4 describes portable units which measure moisture in gases.—Weighing & Control Components, Inc., 206 Lincoln Ave., Hatboro, Penna.
CIRCLE 343 ON READER-SERVICE CARD

MOISTURE CONDENSERS. 2-page bulletin, Form 100, describes self-contained, self-powered, low-cost mechanical moisture condenser.—Zeks Industries, 600 Haverford Rd., Haverford, Penna.
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MAGNETIC CORE MEMORY. 8-page brochure describes line of random-access magnetic core memories.—Computer Control Co., Inc., 983 Concord St., Framingham, Mass.

CIRCLE 345 ON READER-SERVICE CARD

MAGNETIC MEMORIES. 4-page Technical Bulletin 59-J describes Series 3100 magnetic memories with wide range of storage capacities.—Rese Engineering, Inc., 731 Arch St., Phila. 6, Penna.

CIRCLE 346 ON READER-SERVICE CARD

PUNCHED TAPE PROGRAMMER. 2-page bulletin describes and specifies Model TP-813 13-channel punched-tape programmer for airborne applications.—Electronic Engineering Co. of Calif., 1601 East Chestnut Ave., Santa Ana, Calif.

CIRCLE 347 ON READER-SERVICE CARD

SYSTEM BUILDING BLOCKS. 8-page folder contains logic diagrams and complete description of the 5-Mc line of plug-in system building blocks which has been expanded to 35 different and compatible units.—Digital Equipment Corp., Maynard, Mass.

CIRCLE 348 ON READER-SERVICE CARD

COMPUTING RESOLVER TEST SET. 20-page bulletin is "A Primer for Computing Resolvers."—Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.

CIRCLE 349 ON READER-SERVICE CARD

DESIGN ENGINEERS

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RECORDERS

MULTIPOINT RECORDER. 4-page Specification 153-23 describes universal multipoint recorder, which permits change from 2 to 24 points within seconds.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Phila. 44, Pa.

CIRCLE 352 ON READER-SERVICE CARD

GRAPHIC RECORDER. 2-page specification sheet provides descriptive information on graphic recorder Model JY-110, for d-c voltages or current variations vs time.—Nesco Instruments, Inc., 638 W. 17th St., Costa Mesa, Calif.

CIRCLE 353 ON READER-SERVICE CARD

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STRIP CHART RECORDER. 4-page bulletin describes and illustrates Model G-22 dual-channel strip chart recorder.—Varian Assocs., Instrument Div., 611 Hansen Way, Palo Alto, Calif.

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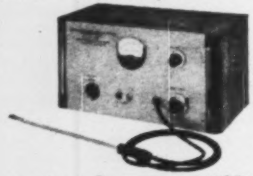

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ICS NEW LITERATURE

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HI-PRESS FLOW INDICATORS. 2-page bulletin 132 describes flow rate measurement meters for pressures up to 1500 psig.—Brooks Instrument Co., Inc., Hatfield, Penna.

CIRCLE 357 ON READER-SERVICE CARD

FUSED QUARTZ. 8-page bulletin, Form EI-1056-1, presents information on fused quartz and fused silica and describes the Amersil method of production.—Engelhard Industries, Inc., Amersil Quartz Div., 685 Ramsey Ave., Hillside 5, N. J.

CIRCLE 358 ON READER-SERVICE CARD

REFRACTOMETERS. 2-page bulletin describes 4 types of pocket refractometers that measure refractive index; % of solids in solution; % of sugar; or % of starch in solution.—Kernco Instruments Co., Inc., Box 1284, Church St. Sta., New York 8, N. Y.

CIRCLE 359 ON READER-SERVICE CARD

PORTABLE ELECTRIC INSTRUMENT. 4-page catalog details full specs and data on German-made Goerz electrodynamic precision instruments, Series 434300.—Physics Research Labs. Inc., Box 555, Hempstead, N. Y.

CIRCLE 360 ON READER-SERVICE CARD

FRONT PANEL MOUNTING FOR TIMERS. 2-page Engineering Data Sheet 86 illustrates and describes front panel mounting, and contains a detailed drawing of a typical customer's panel and panel drilling for the 305 Atcotrol Timer.—Automatic Timing & Controls, Inc., King of Prussia, Penna.

CIRCLE 361 ON READER-SERVICE CARD

VISCOMETER. 2-page Bulletin V-1230 describes viscometers for atmospheric pressure applications.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.

CIRCLE 362 ON READER-SERVICE CARD

TURBINE SUPERVISORY INSTRUMENTS. 12-page Bulletin GEZ-3078 includes description and specifications of a TSI system that charts a permanent record of mechanical performance throughout starting and running periods.—General Electric, Schenectady 5, N. Y.

CIRCLE 363 ON READER-SERVICE CARD

SPECIAL SLIDE RULES. 2-page brochure describes a series of special-purpose slide rules and calculators designed for the chemical industry.—Dyna Slide Co., 600 South Michigan Ave., Chicago 5, Ill.

CIRCLE 364 ON READER-SERVICE CARD

CUSTOM-BUILT DUST HOODS. 2-page Bulletin 600 gives dimensional sketches and description.—Air-Shields, Inc., Hatboro, Penna.

CIRCLE 365 ON READER-SERVICE CARD

GENERATOR & MOTOR GENERATOR. 2-page bulletin describes full line of a-c and d-c generators and motor generators.—Howell Electric Motors Co., 16316 West Seven Mile Rd., Detroit 35, Mich.

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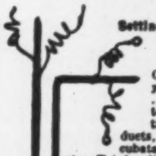

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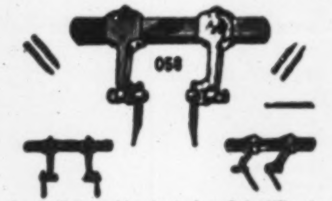

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INDUSTRY NEWS

BAILEY METER CO. has appointed *C. H. Barnard* sales manager in charge of Marketing Department.

C. H. BARNARD
Bailey

J. S. RIDLEY
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C. LAINE
Semi-Elements

MILGO ELECTRONIC CORP., manufacturers of instrumentation systems for the missile industry, announces the appointment of *John S. Ridley* as sales manager.

SEMI-ELEMENTS, INC. announce appointment of *Charles Laine* as sales manager of the Semiconductor Division.

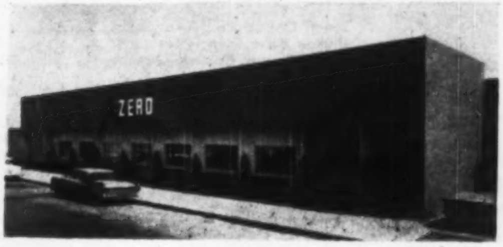
LIBRASCOPE DIV. announces that *Lewis W. Imm* has resigned as president of the division. He will continue his association as a special consultant in the field of computer system development.

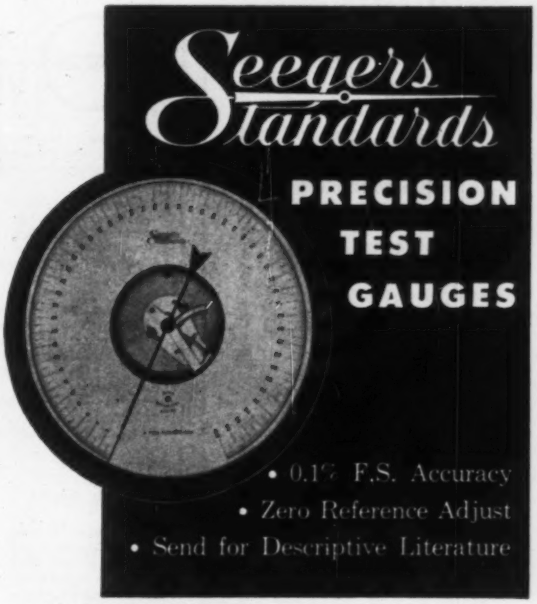
BENSON-LEHNER will sell 67,500 new shares of stock to the public to assist the company expansion.

NATIONAL ELECTRONICS has completed a 23,000-sq-ft addition to its plant in Geneva, Ill., which has doubled the size of this facility. Also, a new Thyratron-Rectifier Division has been set up.

SANGAMO ELECTRIC, which has absorbed the **D G C HARE CO.**, formerly a subsidiary, into the parent company, will design, manufacture and market the magnetic-tape transport systems by the new Electronic Systems Division.

ZERO MFG. CO. has completed a ½-million-dollar, 33,600-sq-ft facility for the manufacture of its aluminum military shipping/storage containers.

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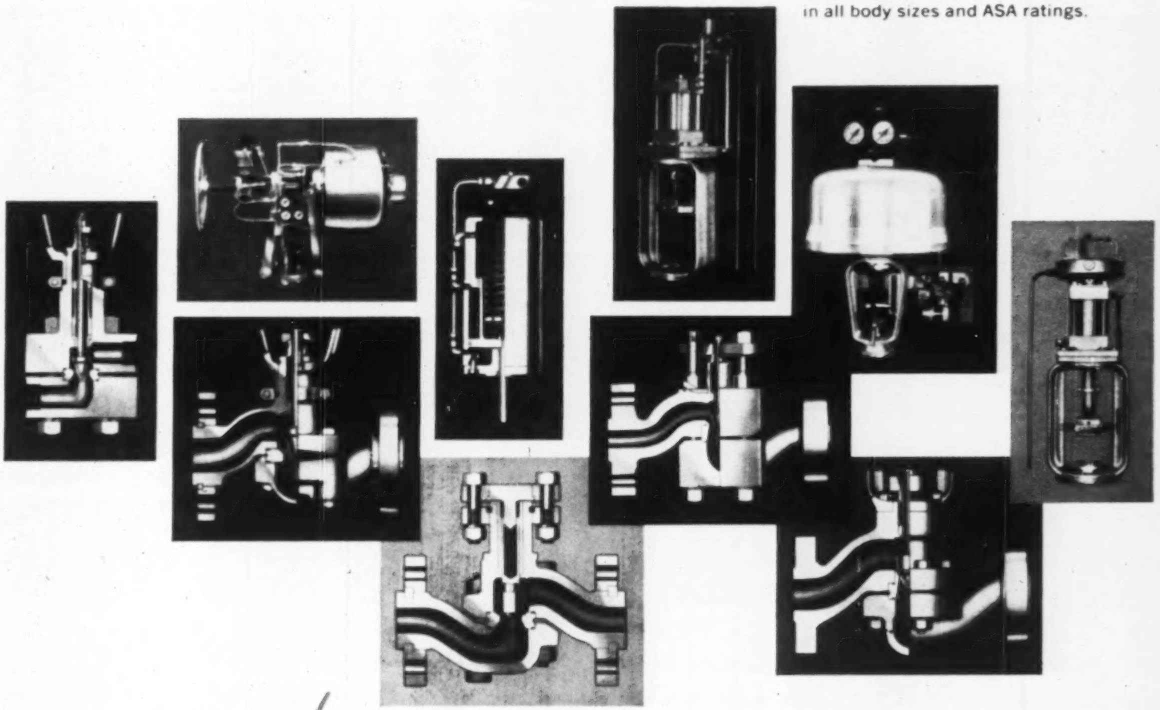

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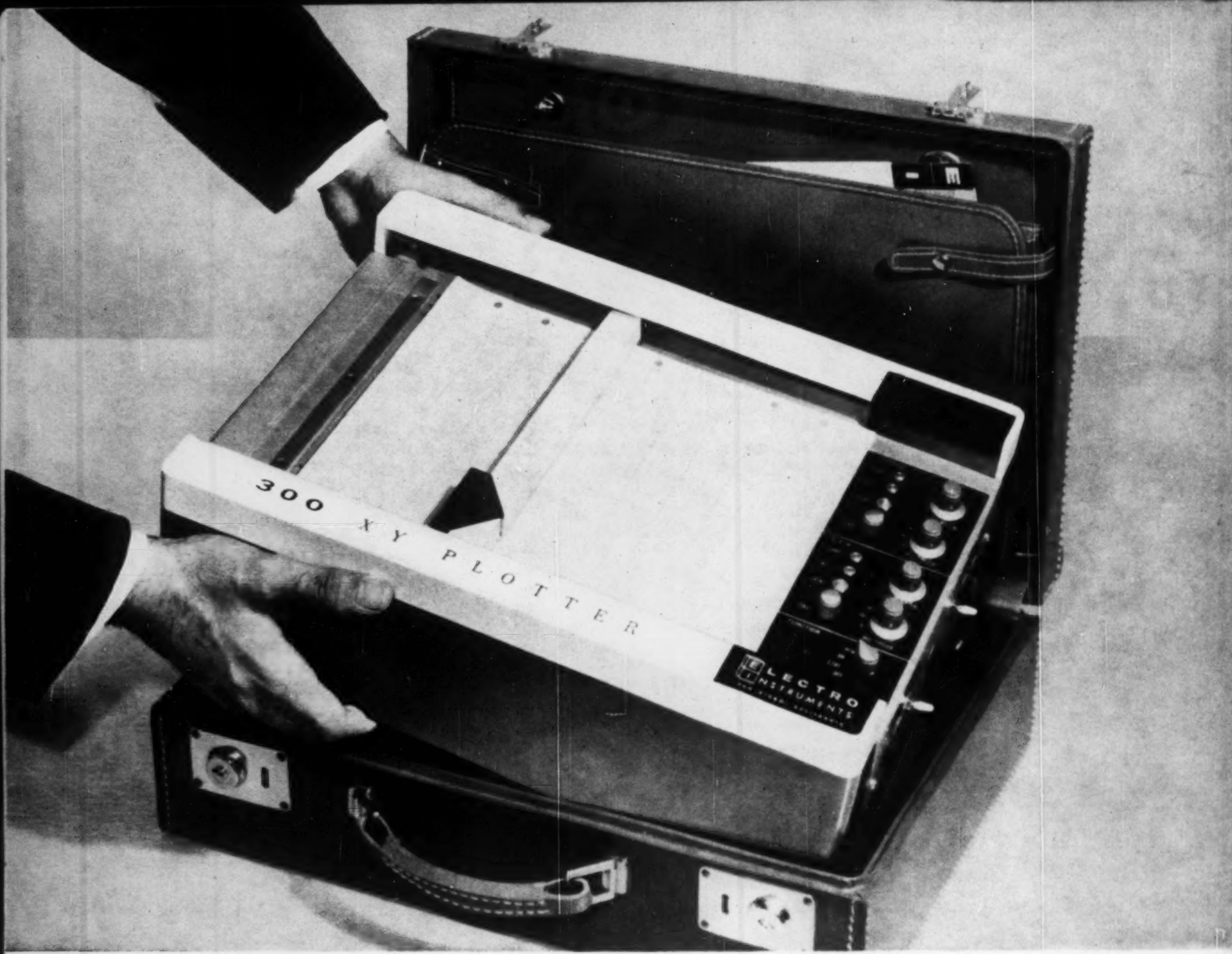

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